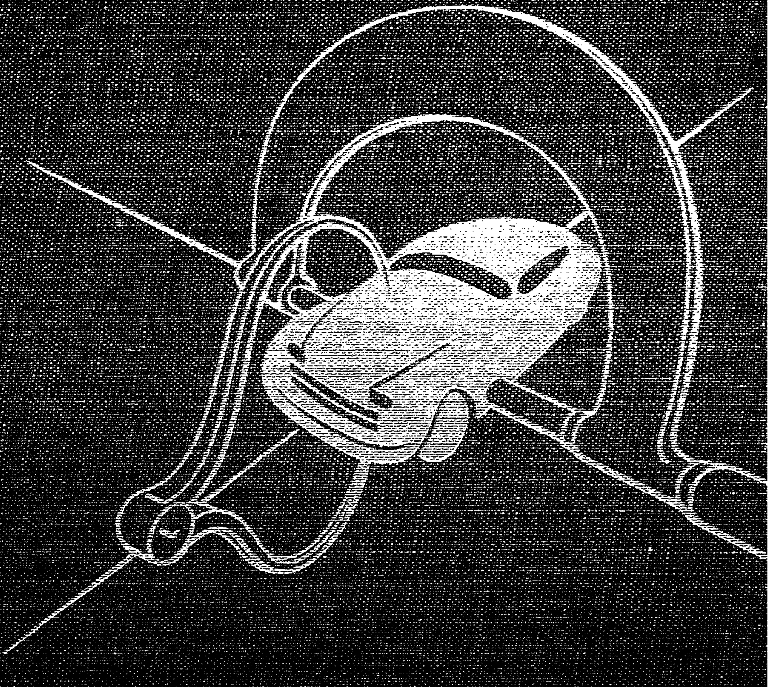
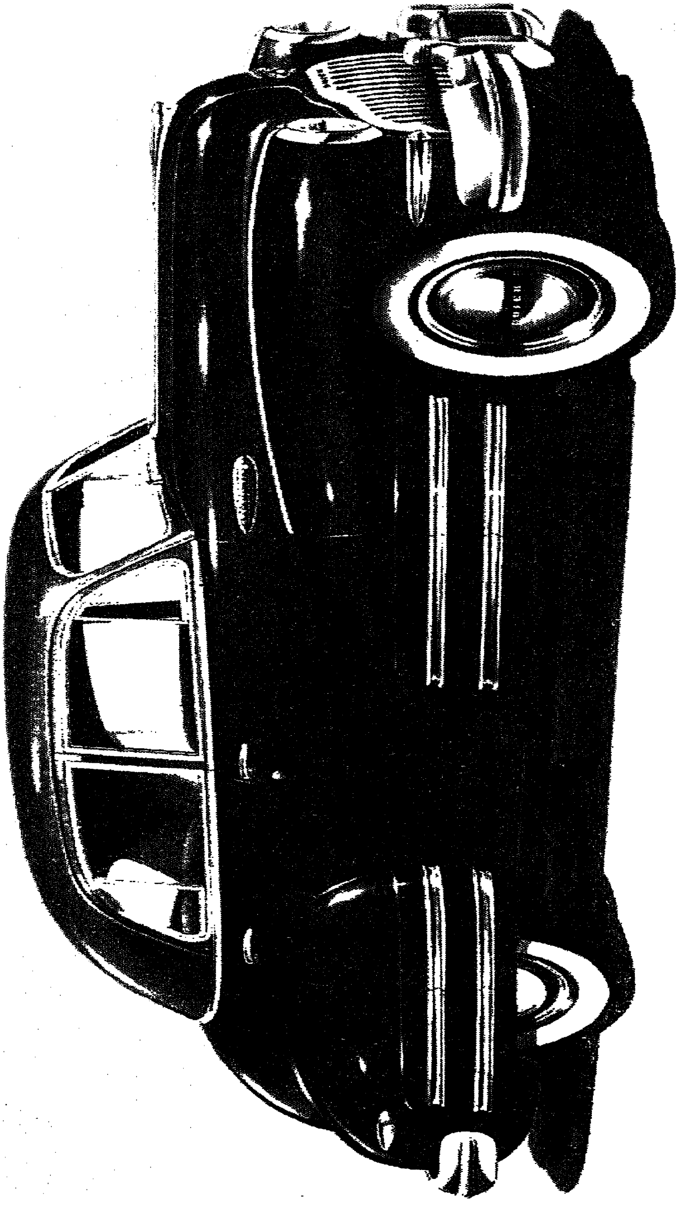
AUTOMOBILE ENGINEERING





AUTOMOBILE ENGINEERING

A HOME-STUDY COURSE AND GENERAL REFERENCE WORK *on the* Construction, Care, and Repair of Cars and Trucks; on Ignition and Starting Systems; also Instructions on Diesel Engines; Service Station Operation

Prepared by a Staff
of Automobile Experts
Under the Supervision of
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OVER FIFTEEN HUNDRED ILLUSTRATIONS • SIX VOLUMES

1945

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FOREWORD

ALTHOUGH recorded history is not wholly agreed as to the first man in America to perfect and operate an automobile, this honor is generally accorded to Charles E. Duryea of Springfield, Massachusetts, who on September 12, 1892, operated a Duryea gasoline automobile in that city. By the year 1900, a number of "gasoline buggies" were in process of manufacture and by 1910 automobile building in the United States had begun to assume serious proportions. Quantity production methods have resulted in the building of over fifty-five million passenger cars and almost four million trucks.

Approximately, five hundred thousand persons are engaged in the production of automobiles, with a payroll of approximately seven hundred million dollars each year. The total number of jobs made possible by motor transport, which includes automobile manufacture, petroleum refining, sales and servicing, road construction, etc., is over six million each year.

Our highway systems total over nine hundred thousand miles of hard surfaced highways. Expenditures for highways in a recent year totaled approximately one billion dollars. Taxes paid by the automobile industry total almost one and one-half billion dollars yearly. Gasoline consumption is estimated at about twenty trillion gallons yearly and the consumption of automobile tires is in excess of fifty million. It is estimated that the vehicle miles traveled are more than one hundred fifty trillion yearly.

As a result of the highly developed skill of automobile production, the call for old-fashioned *repair service* is gradually being displaced by a call for a new type of man trained in *maintenance service.*

Perhaps the first line of defense, so to speak, against the needs of the modern motor car is the list of three hundred and twenty-five thousand gasoline service stations offering maintenance service in varying degrees. Next in point of number comes sixty-five thousand general repair garages and then some thirty-five thousand car dealers. The men required to man all of these stations require specialized training.

Specialized equipment has been developed, designed to help the garage men diagnose motor car troubles. It is a matter of record that the scientific equipment is more accurate than the human element and the up-to-date stations are requiring men who can handle this type of equipment.

There is no need to guess the type of lubricant required by any part of the automobile, nor is there any need to make an estimate or guess as to the exact amount of clearance to be allowed at any one point in the adjustment of the intricate automotive assemblage. Accurate information is provided in the way of lubrication charts, wiring diagrams and data sheets.

Service men have taken it upon themselves to attempt to make the automobile fool-proof and to make it a safer vehicle to go upon the highways. This has resulted in safety campaigns in the servicing of brakes, headlights, and the third vital item, front axle and steering geometry.

Although the principle of the Diesel or oil engine is practically as old as that of the gasoline engine, which has been developed on the Otto cycle principle, it was not until comparatively recent years that the Diesel has begun to find a very large place in the transportation field. Diesel engines have been speeded up and light weight Diesels are being rotated approximately as fast as heavier gasoline engines. The Diesel engines are finding their place in road tractors, road machinery, farm tractors, buses, and trucks. The auto-mechanic, who has a well-grounded understanding of the principles and practices common in the automotive field, has little difficulty to transplant himself into the Diesel engine service field. It is anticipated by many that further development of the Diesel will insure its place in the passenger car transportation field.

In the automobile racing field there have been a number of outstanding developments within recent years, chief of which is the propulsion of a motor vehicle over the salt beds of Utah at a speed in excess of three hundred miles per hour. Each year has seen the breaking of speedway records with higher and more efficient performances and records. There has been a tendency for road racing to come back into favor and this is being looked upon with special appreciation by some car manufacturers who are desirous of increasing the performance of their particular automobile. In this field the competition of foreign-made automobiles is being felt.

Considerable interest continues to be exhibited in the possibilities of a rear-engined power plant. More complete streamlining is always a matter of consideration by engineers. Fuel economy is receiving much consideration and is destined to play a part in engineering practice more and more. In the truck and tractor field for highway transportation of freight, there is a definite tendency toward the use of the pancake type of engine with the cab over it at the front of the vehicle. Outstanding examples of free design in engine placement are in placing engines behind the rear axle in buses and the use of the twin drive.

A great deal of the short haul business, which was handled at one time by the railroads, is now handled by trucks and tractor-trailers. The use of light-weight, high-speed, high-compression engines, similar to those utilized in the passenger car field, has become a general practice in highway freight service. This serves to prove the contention of automobile engineers that the automobile has a great deal more power than is really required for ordinary passenger car use. This fact has fostered the development of the house-type and display-type trailer coach drawn by passenger cars.

The last few years has seen a standardization taking place in the aviation field with the result that aviation industry is partaking more and more of the nature of a large public utility, such as a railroad or a steamship line. Young engineers interested in a life of service in this industry need to recognize this particular fact. The training required by these individuals is of an exceedingly high order. For every ship in the air there is a crew estimated at from five to ten men on the ground. It is in this field that many young automotive engineers are finding an outlet for their skills. It is now possible to travel into almost any part of the United States within twenty-four hours by means of regularly scheduled air-line service. It is also possible to travel into almost any part of the globe at exceedingly high rates of speed, using only the regularly established air-line service. More and more we are finding that mail, express, and freight are being handled by this service. Some of the most interesting and recent developments in the mining field, in the North American Continent and elsewhere, are being made possible through the use of the airplane for transportation of men and mining machinery into out-of-the-way places. While it is true that the development of light aircraft for personal use of the aviator has had more or less of a quiet season, impetus is being given to this development by certain work of the Civil Aeronautics Authority of the Federal Government.

Intimately tied up with all of the various phases of automotive progress in the field of transportation is the question of man-power. The automotive industry continues to afford to red-blooded American youths, who are willing and anxious to train themselves in the highly technical lines of service, one of the most popular and profitable fields of training and service. The young engineer, however, must realize that with all of the romance and interest in any phase of this great industry there comes also the need for scientific and exact application of knowledge and skill.

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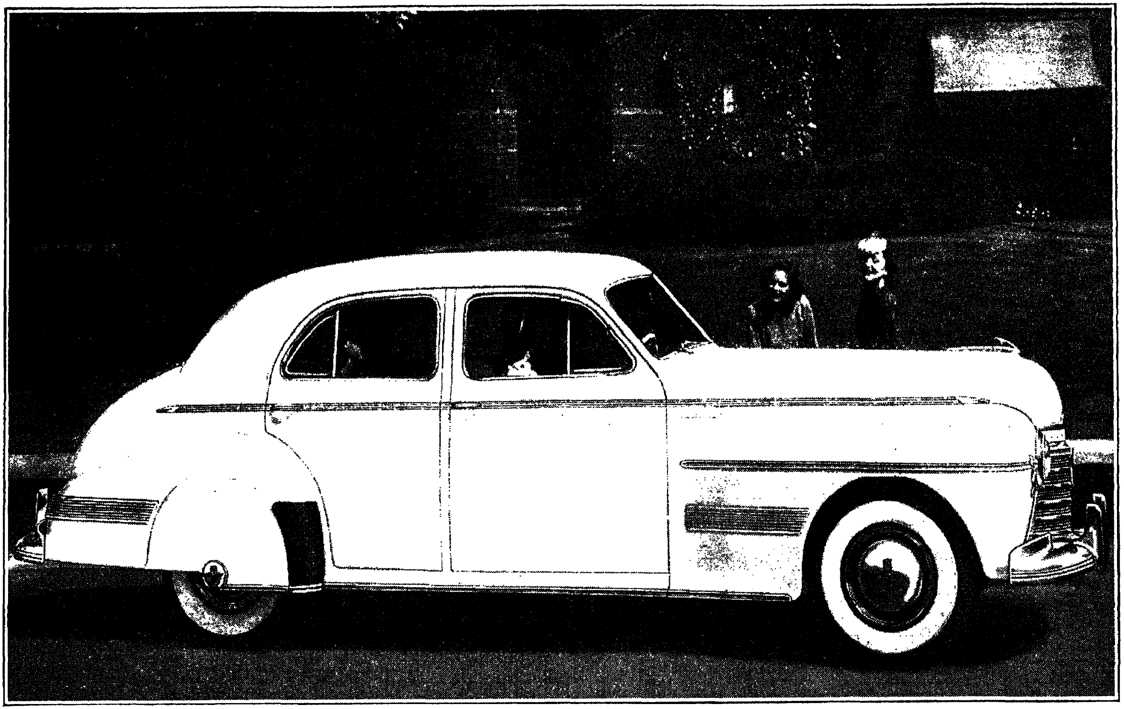


1941 OLDSMOBILE CUSTOM CRUISER FOUR-DOOR SEDAN

Courtesy of Olds Motor Works

CARBURETORS

PART I

FUNDAMENTAL PRINCIPLES

Many mechanics, who are quite at home when repairing the purely mechanical phases of the automobile, find themselves more or less at a loss to know just how to proceed or how to interpret the instructions given when studying the action of the fuel system and particularly with reference to the action of the carburetor. The illustrated instructions that follow will serve to clear up the scientific theories involved in carburetor design and construction.

Function of Carburetor. The carburetor is a device designed to handle liquid fuel and so mix it with air, which is required to support combustion, that a highly explosive mixture is formed. The laws governing this mixture are well known. There are a number of methods by which the mixture may be attained, that is, carburetors will fall within certain definite classes which will be described later. It is sufficient at this point for the reader to know that a very definite mixture must be secured if the combustion is to be supported and the most miles per gallon secured from the gasoline used in the car.

Exact Carburetion. Exact carburetion is a scientific accomplishment. Engineers have spent a great deal of time and money to design carburetors to give the exact and proper mixtures of air and gasoline required at all engine speeds. Except for the fact that it is necessary to throttle an engine, the design of carburetors would be comparatively simple. As a matter of fact, all that would be needed would be a needle valve which could be screwed down to shut off the amount of gasoline entering with the given amount of air. This, however, would not do for more than one speed and the engine would not throttle with this sort of device, which is, in reality, a mixing valve rather than a carburetor.

Exact carburetion at all speeds is a thing which has long been the ideal sought by the engineers. Present-day carburetors are rather efficient in this respect. However, the automechanic, without the knowledge of the underlying principles of carburetor design, is very likely to undo much of the good work of the engineer. For this reason a very definite attempt should be made to master the information as given herein.

A carburetor expert is one who not only has had considerable experience with carburetion but who also understands the fundamental principles which follow. Not only does he understand them but they are applied by him rather unconsciously, just as a good driver steers the car through traffic and manipulates his brake, clutch, and throttle almost without conscious thought.

Weight of Air. Most people do not appreciate the fact that the great sea of air in which we are living has appreciable weight. However, we are living at what might be termed the bottom of an ocean of air. As to the exact height of this ocean of air, no one can say definitely. It is variously estimated at about 200 miles in depth. Perhaps the most definite thing we know about it is that when aeroplanes reach a height of about eight miles, they hit what is termed the "ceiling," that is, the air at that point becomes so light that it is impossible to push the heavier-than-air machine higher into the atmosphere. While the air man calls this the "ceiling," it is not so in reality. No one knows definitely how much further the air goes out into limitless space.

In order to support combustion at these high altitudes, the air man usually makes use of the supercharger. This is a device, understood by most mechanics, to force in greater quantities of air in order to secure the desired oxygen and support the combustion in a better fashion. One farmer may raise fifteen bushels of wheat to one acre and another farmer raise sixty bushels to the acre. The first farmer has to gather wheat from four acres to have as much as the second farmer gets from one acre. So it is with the atmosphere at the "ceiling" a great many more cubic feet of air must be used in order to get the same amount of oxygen.

Inasmuch as we are living within this sea of air at the bottom of it, we have no sense which tells us its weight; nor are we ordinarily really conscious of it unless it becomes exceedingly dry or something of that sort. If we dip a gallon pail into a larger vessel of water, we do not appreciate the weight of the water until we attempt to lift the gallon pail, with its full measure of water, from the rest of the body of water. Unfortunately we cannot do a similar thing with reference to the air. If we could, we would then realize the weight of it. The fact does remain that air has weight and this fixed weight or pressure, as it is ordinarily termed, has a very definite bearing on carburetor design and construction and just as much bearing on the exact setting of carburetors, which feature, of course, is the one which the automechanic is interested in. The ideal mixture of air and gasoline is one pound of gasoline to fifteen pounds of air. In order to get an idea of the amount of air contained in fifteen pounds, it would be well to study the methods of weighing air.

Suppose two vessels, constructed air-tight, each of which contain one cubic foot, are placed on the scales as indicated in Fig. 1. The vessels themselves are exactly the same weight. Now we will take one of these and attach a vacuum pump to it and exhaust all the air from the vessel and seal it. It will be found that it will be necessary to place one and one-quarter ounces of weight on the vessel, which has had the air exhausted from it, in order to balance the container on the opposite side of the scale. In other words, each cubic foot of air weighs one and one-quarter ounces. Now in order to secure 15 ounces of air it would be necessary to have twelve cubic feet. Accordingly it will be seen that 15 ounces of air, placed on the one arm of the balance, would balance twelve cubic feet of air, placed on the other one, as shown in Fig. 2. Of course the weight of the container would have to be accounted for.

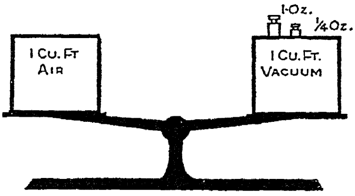


Fig. 1. One cubic foot of air is balanced by 1¼ ounces.

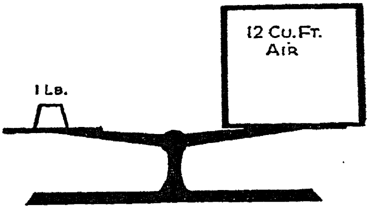


Fig. 2. One pound weight balances 12 cubic feet of air.

Relative Weight of Gasoline and Air for Correct Mixture. It will be seen that if we were to place one cubic foot of air on one side of the balance, as shown in Fig. 1, that it would be balanced with one and one-quarter ounces of gasoline on the other side. While the weight is exactly the same, the bulk is different. However, if we were to place one and one-quarter ounces of gasoline in a cubic foot of air, the mixture would be fifteen times too rich, so that it would be necessary to have fifteen cubic feet of air with which to mix the one and one-quarter ounces of gasoline in order to provide the best possible mixture for economical and powerful operation of the engine.

Looking at it the other way, it will be found that there are about seven and one-half teaspoonfuls of gasoline in the one and one-quarter ounces of gasoline. In other words, it takes barely one-half teaspoonful of gasoline to mix with a cubic foot of air in order to secure the proper mixture.

Bulk of Gasoline as Compared to Bulk of Air to Support Combustion. The question which arises is naturally one of how much larger the cubic foot of air is than the teaspoonful of gas. The cubic foot of air weighs just fifteen times as much, but how many times larger is it? A cubic foot of gasoline will be found to weigh almost fifty pounds. Now fifty pounds will equal 800 ounces. The cubic foot of air, with its weight of one and one-quarter ounces, would have to be multiplied by 640 to have as much weight as a cubic foot of gasoline; and it must be remembered that fifteen times as much air is required as gasoline when figured by weight. Accordingly, in order to use up a cubic foot of gasoline, fifteen times 640 is needed or 9600 cubic feet of air is used in the average gasoline engine for each cubic foot of gasoline. If it is desired to convert this into gallons, the same ratio holds. For every gallon of gasoline there must be approximately 10,000 gallons of air burned, although we are not in the habit of thinking of air being measured by the gallon. It does, however, serve as a basis of comparison. The problem then is how to mix the two in an economical fashion so as not to waste any of the gasoline.

Gasoline and Air Mixture. It will be remembered that one-half teaspoon of gas and a cubic foot of air is the proportion of about 1 to 10,000 by volume. In order to secure a good mixture of the liquid gasoline fuel, it is first necessary to have it vaporized. When a liquid is vaporized, it occupies more space; it will also float in the air. These two features are quite valuable ones and are made use of in carburetion. There are quite a number of ways in which the one-half teaspoonful of gasoline may be vaporized to mix with the cubic foot of air in proper fashion. If the one-half teaspoonful of gasoline were to be poured into the cubic foot of air, as indicated in Fig. 3, this would not constitute a fuel mixture, since the gasoline would simply drop to the bottom of the vessel and remain there until it was slowly vaporized by normal evaporation, which is rather slow with our present heavy grades of fuel.

Vaporization. Vaporization is evaporation. Evaporation occurs at all temperatures. Even snow and ice will evaporate, although the process is very slow. On warm days the water from the streams and lakes will evaporate very rapidly. The heat of the stove helps to boil the water and evaporates it quickly. Any liquid placed in contact with the air will start to evaporate and the fact that it is doing so is made noticeable by the characteristic odor of the liquid which is being evaporated. This is exactly the reason you can smell the gasoline as you approach the gasoline station. The loss to the service station from evaporation is not slight, especially in extremely warm weather or where a very high grade of gasoline is carried. As a rule the evaporated particles are not visible to the eye. In some cases we can see the fog of the evaporated fuel or liquid. It is possible to speed up vaporization by a number of methods.

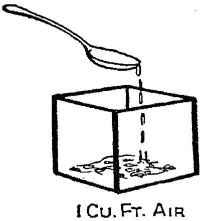


Fig. 3. Pouring a teaspoonful of gasoline into a cubic foot of air does not constitute mixing it.

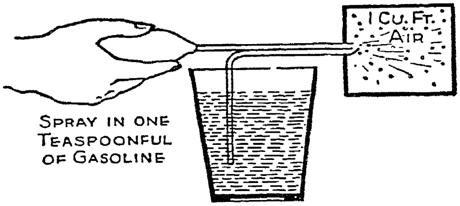

1 Cu. Ft. Air
Spray in one Teaspoonful of Gasoline

Fig. 4. Spraying a teaspoonful of gasoline into one cubic foot of air makes a combustible mixture.

The three methods of vaporization, which may be made use of by the carburetor manufacturers in designing and building the carburetor so that the gasoline and air mixture may be maintained at a 1 to 15 ratio, are atomization by spraying, vaporization by means of heat, and vaporization by production of a vacuum. These should be held in mind constantly when studying carburetion to see just how and where each one is made use of.

Vaporization by Spraying. A vapor is a gasified liquid—in this instance the gasoline. If an atomizer were used, as shown in Fig. 4, it would be possible to spray one-half teaspoonful of gasoline into the cubic foot of air very quickly and have it fairly well mixed with the air, since it enters the air in the form of a mist. Everyone knows that some of the particles of the liquid coming from an atomizer are larger than others. These may fall to the bottom of the vessel containing the air. Naturally this vaporization is less perfect than when the particles are broken up so small and fine that they are not visible to the eye.

The use of the atomizer, as shown in Fig. 4, very simply represents one of the most important elements of design in carburetion. When the bulb is pressed, the air is forced through one tube out past a small opening in the other tube, which runs down into the gasoline container. The force of the air circulation past the small opening in the gasoline tube causes a suction which draws portions of the gasoline up through the tube. As it draws this gasoline out, the air from the bulb strikes the fuel and breaks it up into small particles or, in other words, it is atomized. Atom is a term applied to very small parts of any element and atomization means breaking into small particles. The application of this principle of atomization by spraying will be explained at a later point in this work.

Vaporization by Means of Heat. An easy way in which to vaporize a liquid is to apply heat to it. If we were to apply the heat from a Bunsen burner to one-half teaspoonful of gasoline, as shown in Fig. 5, the gasoline would very quickly be driven off in the form of a heavy vapor. The heat aids it in rising and, if the vessel containing the cubic foot of air were immediately above it, a very good mixture would be secured between the air and the vaporized gasoline. Naturally the greater the heat the more rapid the vaporization.

This principle is made use of in the carburetor by several methods. The older method was to make use of a stove, which was hooked on to the exhaust pipe at a point close to the carburetor so that the air being drawn into the carburetor was first passed around the exhaust pipe and the heat thus picked up was carried into the carburetor to warm the carburetor parts and to assist in vaporization. In other words, the heat was carried in by the air. While stoves are still made use of for this work, later practice is the use of "hot-spots" in the manifold or special manifold tubes so that the gasoline as it is sprayed from the carburetor comes in direct contact with the heated surface. This is somewhat like dropping a drop of water on a red hot stove. It is vaporized instantly.

Vaporization by Production of Vacuum. Owing to the fact that we are living in a vast sea of air, it is rather difficult to conceive of any space where there is no air. We look at a bottle and say it is empty because we can see nothing in it. We do not mean exactly what we say and we realize, of course, that it is filled with air. Being filled with air, there is a very definite air pressure of approximately fifteen pounds per inch on the inside of the bottle as well as on the outside of the bottle. If the bottle or flask is filled half full of water, as indicated in Fig. 6, and then connected up to a vacuum pump, as shown, it will be possible to exhaust the air from it with the result that, at a temperature slightly above the room temperature, the water may be made to boil without any additional heat. Ordinarily water boils at 212° F. The fact that it does not boil at a lower temperature is due solely to the pressure of the air upon the water.

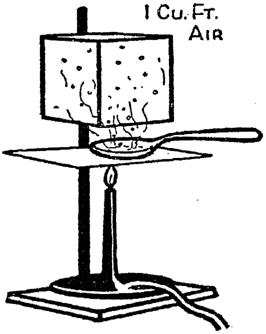


Fig. 5. Using heat to vaporize gasoline and mix it with air.

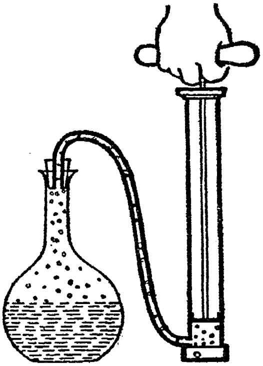


Fig. 6. The effects of vacuum on the boiling point of gasoline.

If all of the pressure could be removed from the water in the flask, it would boil violently at 80° to 90° F.

This feature of the production of a vacuum over the liquid fuel has a very important place in the design of carburetors. In order to secure a vacuum into which the fuel may be discharged, a venturi tube is made use of. The venturi tube, in combination with the suction of the engine, thus provides a vacuum of fairly high order so that the gasoline, while being sprayed into the carburetor by means of the piston suction, is also vaporized, owing to the effect of the vacuum thus created.

Atmospheric Pressure. It is known that the atmosphere has weight and that the atmosphere is miles deep. The depth of the atmosphere determines to no slight extent the amount of pressure at the surface of the earth. This is illustrated by the fact that the higher we pile bricks on the hod, the heavier the hod. If the air is piled up for 100 to 200 miles, it becomes heavier and heavier. While spread out very thin or highly rarified in the upper realms nevertheless, the pressure at the earth's surface is maintained at 14.7 pounds per square inch. We are so used to this pressure, in fact our existence depends upon it continually, that we do not stop to think of this pressure or weight. The pressure is not only downward, but it is in every direction so that air is continually seeking to enter any opening or any point in which there is a tendency to create a vacuum.

Proof of Air Pressure. In order to prove that air pressure is something very definite and positive and ever-present, any one can perform this simple experiment. Secure an empty oil can of one-gallon capacity. Have a tight-fitting cork at hand but do not place it in the can. Pour a half-pint of water into the can and set the can on the stove top. Heat the can until the water within it is boiling and steam is being passed off from the top at a rapid rate. Lift the can from the stove and quickly insert the cork. Be sure to insert the cork absolutely tight. Within a very short time, the can will start to crumple and buckle. This crumpling and buckling will continue until the can looks as though it had been run over with an automobile. You have demonstrated in this simple experiment three principles or facts. One of these is that air has pressure and another is the vacuum, established by the fact that when the water was boiling the steam came up into the can and drove almost all of the air out of the can so that nothing but steam remained within. When the can was removed from the stove, the steam condensed back to water, leaving a vacuum. This vacuum was immediately offset by the normal air pressure which, in an attempt to get into the can, forced in the sides of it, crushing it together. The third thing which was demonstrated was the fact that a small amount of liquid could be made to fill a very much larger space by evaporation, as was done when the water was boiled and it filled the entire can, driving off the air ahead of it.

The question might arise as to where there was sufficient pressure to crush the can, but it must be remembered that there was 14.7 pounds pressure on every square inch of the surface of the can. There was no pressure on the inside, since the steam was condensed back to water, because the water occupied a relatively small portion of the interior of the can. This experiment is illustrated in Fig. 7.

Vacuum. A conception difficult to establish in the mind of the average person is vacuum and just what it might be. He realizes, of course, if he stops to think about it, that vacuum is a place where there is nothing present, not even air. The question then is—what is a partial vacuum? If one-half of the air is removed from a sealed container and no more air enters, the container is still filled. The reason for this is, that air, as all gases, expands when pressure is removed from it. However, this condition would give a pressure within the container of about half of the air pressure on the outside and this is spoken of as a partial vacuum. In carburetor work a true vacuum is never secured. A partial vacuum is constantly present when the engine is running.

Measuring Vacuum. The weather man figures a great deal on the height of the mercury in the mercurial barometer. It is a well-known fact that the atmospheric pressure indicates the general weather conditions. Disturbances of the air throughout the different parts of the world are reflected in other disturbances in other parts of the earth's surface. A very slight variation in pressure is sufficient to create storms. The mercury column is the most usual method of measuring the atmospheric pressure. Atmospheric pressure is measured at sea level.

Many years ago it was discovered that it was possible to pump water from a well by means of a suction pump, as long as the well did not exceed approximately 34 feet in depth. The pump is used to create a vacuum and the normal air pressure on the upper surface of the water forces it to flow up into the pump stock after the air, which has been removed above it. In other words, a normal air pressure will lift water to a height of 34 feet if all pressure has been removed from the tube in which the water is to rise.

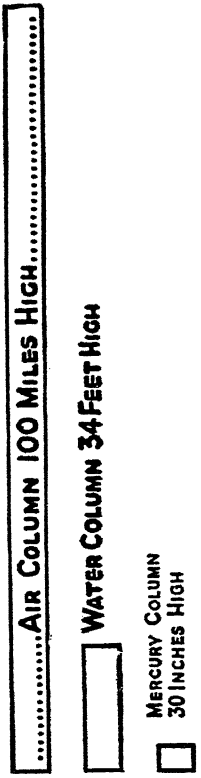

AIR COLUMN 100 MILES HIGH
WATER COLUMN 34 FEET HIGH
MERCURY COLUMN 30 INCHES HIGH

Fig. 8. Comparing the weight of pressure downward of Air, Water, and Mercury. Columns of the height shown, each have a downward and outward pressure of 14.7 pounds for each square inch.

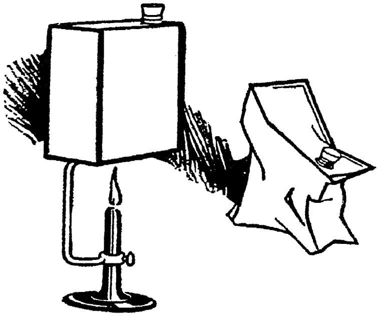


Fig. 7. Positive proof of the weight or pressure of air.

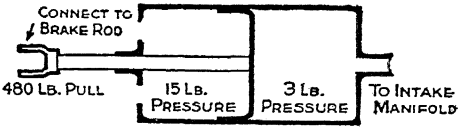


Fig. 9. Showing how the vacuum created by the engine may be utilized for work

The heaviest fluid known to science is mercury. It is found that a column of mercury 30 inches high weighs just as much per square inch as a column of water 34 feet high. Either a column of water 34 feet high or a column of mercury 30 inches high just balances a column of air over a hundred miles high, according to scientists. The rough comparison of these figures is shown in Fig. 8.

As an experiment, take a glass tube 32 inches or more in length and fill it with mercury. Have a small vessel of mercury at hand and insert the lower end of this tube into the vessel of mercury, while keeping one finger pressed tight over the upper end of the tube. Note the height at which the mercury stands, measuring it from the top of the surface of the mercury in the open vessel to the point at which the mercury stands in the tube. The device you have constructed is a barometer and it measures carefully the air pressure at which the experiment is performed, ordinarily it will be around 29 to 30 inches in height. At sea level, it should be approximately 30 inches. However, it will be found that there is a portion of the tube in which there is no mercury. In this portion of the tube there is a perfect vacuum, because there was no air in the tube to start with. If the finger is lifted from the tube, it will be found that the mercury immediately runs into the vessel below. What is it that holds the mercury up into the tube?

Putting the Force of Vacuum to Work. The ability of vacuum to do work is not generally appreciated, although there are a number of devices on the market which make use of the vacuum created by the engine in its normal intake of fuel and air operation. One of the most common uses to which the vacuum has been placed is the drawing of the fuel supply for the engine by means of the vacuum tank. The vacuum tank is nothing more than a device so arranged that air may be drawn from the inside of it and a valve opened to the main supply tank at the rear of the car, so that air, in trying to enter the vacuum tank, forces the fuel ahead of it through the fuel supply line to the vacuum tank.

A device which illustrates the work which may be done by vacuum is shown in Fig. 9. This is a cross section of a vacuum brake. It consists of a cylinder with a cup washer piston on the end of a pull or piston rod. A tube connects one end of this cylinder to the intake manifold of the engine at a point just above the carburetor, which is the greatest point of vacuum. Now, as the engine is running, the air is drawn from the sealed cylinder until it has about 3 pounds pressure left—that is, in a good engine a vacuum of about 12 pounds or 22 to 24 inches on the mercury may be secured. The normal air pressure on the opposite side of this cup washer piston is approximately 15 pounds, so it will be seen that for every 3 pounds of pressure within the sealed end there are approximately 15 pounds on the other side of the washer, forcing the piston into the cylinder. A 7-inch cylinder of this general design will develop approximately 450 pounds pressure or pull, which may be applied to the brake rod. This is exactly the same principle made use of whenever the vacuum is used for any work. There are other devices which are occasionally attached to the engine intake manifold.

The force of vacuum is depended upon to develop the suction for the spraying or atomization elements of carburetor design. A vacuum which is created just above the venturi, in what is known as the mixing chamber of the carburetor, is the point at which the major portions of the combining of the air and fuel mixture occurs.

NORMAL ATMOSPHERIC PRESSURE REGULATES CARBURETOR DESIGN

The normal air pressure is approximately fifteen pounds per inch. It is always present and immediately seeks a way into any space which is vacated by another element or from which other air has been drawn. Vacuums may be complete, but as a rule are only partial. This is especially true with reference to the carburetor. A series of illustrations have been especially prepared to show the action of the carburetor as the pistons within the cylinder draw or suck air and fuel through the carburetor.

Referring to Fig. 10, it will be noticed that a piston has been provided in a cylinder and a cross tube is open to the air. Now, as the piston is pulled downward, it is readily seen that the air will follow in through the tube. Since there is no restraint to the amount of air which may enter, normal air pressure is found throughout the tube and cylinder.

In Fig. 11, the same tube is shown with the addition of a bowl of gasoline connected to the cross tube by means of a smaller tube. It will also be noted in this figure that the end of the cross tube has been closed. Now when the piston is started traveling downward, the air which is in the cross tube and upper part of the cylinder will become thinned out or a partial vacuum will be created. This results in suction on the gasoline bowl and in gasoline being forced into the cross tube where it mingles with the air which was already in the tube. As the piston travels downward, the vacuum becomes more and more complete and a richer and richer fuel flow will occur.

In Fig. 10 we have shown how air may be drawn in, and in Fig. 11 we have shown how gasoline may be drawn in by the piston action or suction. In Fig. 12 the end of the cross tube has been opened again, otherwise the arrangement is similar to that in Fig. 11. It will be noted that both air and gasoline will be drawn as the suction of the piston acts upon the device. There is a constant flow of air mixed in with the rather constant flow of gasoline. The mixture consequently does not become so rich as that shown in Fig. 11. As the amount of gasoline is very small in proportion to the amount of air, the gasoline tube is relatively much smaller than the air opening. This holds in all carburetor design. The speed with which the piston travels regulates the degree of vacuum. The faster it travels, the greater the suction and the more rapid the action of the fuel flow as well as the air flow.

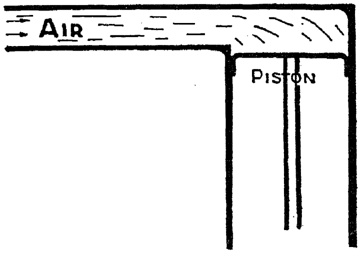


Fig. 10. Action of a simple piston in a cylinder in creating suction. (Valves omitted.)

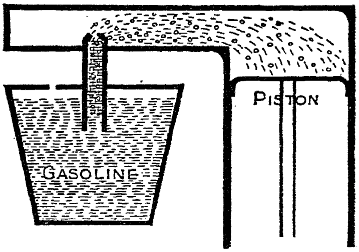


Fig. 11. Showing how the piston will draw in raw gasoline if no air vent is provided.

Regulating Flow of Air and Gasoline. From the rather simple starting point just described and considering the same principles, the following illustrations will serve to show how engineers make use of mechanical devices and scientific principles to control and regulate the flow of air and gasoline so as to secure a proper gasoline mixture.

A comparatively simple device, such as that shown in Fig. 12, could be designed with fixed air and gasoline openings so that it would serve very well to operate an engine at a fixed speed. It would not be possible to throttle the engine, neither would it compensate for varying loads. In Fig. 13, a gasoline needle has been added. This is so arranged as to control the amount of gasoline which will flow through the gasoline tube to mix with the incoming air. The wider the needle is open the more gasoline; and the further into its seat it is screwed, the less gasoline flows through the tube. By the use of such a device, it is possible to adjust this simple carburetor for varying loads and varying speeds of any one engine; but it still does not lend itself to throttling, as is necessary with the automobile.

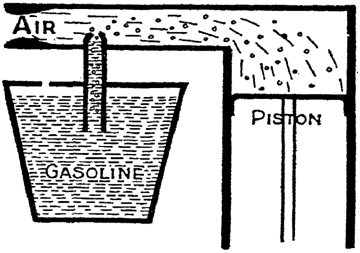


Fig. 12. Showing a simple carburetor—a gasoline tube in an air tube supplied from a vessel of gasoline.

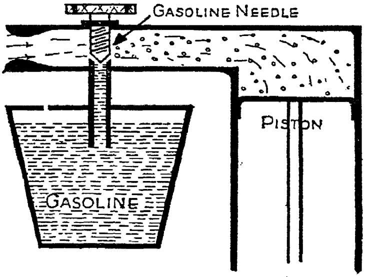


Fig. 13. Simple Gasoline Needle Adjustment.

It must be remembered that in all cases, with all carburetors, it is necessary to have the gasoline and air mixture at approximately 1 to 15. This is irrespective of the speed of the engine or the load of it. For this reason it will be seen that the design of the carburetor becomes more and more complex.

There is another method of controlling the proportions of air and gasoline. This is what is known as the auxiliary air opening and is shown in Fig. 14. It will be noted that the cross tube has been provided with two air openings—the original one at the end and another one at the top. The air entering at the top mingles with the air which has entered at the end of the tube and picked up the gasoline, so that the mixture is leaned out. Here again we have a device which could be designed for any fixed engine speed and fixed engine load, but it does not lend itself to throttling nor does it automatically compensate for variation in speed or in load.

Automatic Control of Air and Fuel Mixture. As has been stated, it is necessary to have a device which will automatically control and hold the air and fuel mixture within the limits of approximately 15 to 1, irrespective of engine speed or engine load.

Auxiliary Air Valves. Some of the first attempts to design carburetors led to the discovery of the auxiliary air valve as a practical unit for automatic control of the fuel mixture and holding it within the prescribed limits of 1 to 15. The application of a valve of this type to the auxiliary air intake opening is illustrated in Fig. 15. When the engine is running, the piston, on the down stroke, draws air in through the end of the cross tube which picks up the gasoline as it passes the gasoline nozzle or tube. This rich mixture then passes the auxiliary air valve and enters the cylinder. As the speed of the engine increases, the amount of air coming in is increased along with the suction and this increased suction will open the auxiliary air valve a distance, depending upon the amount of vacuum or suction, so that in an automatic way the suction itself increases the auxiliary air valve opening and allows an increasingly large amount of auxiliary air to enter and lean out the mixture which otherwise would grow too rich.

A simple carburetor, such as shown in Fig. 12, can only be designed for one fixed engine speed and fixed engine load. When an attempt is made to increase the engine speed beyond this point, it is found that the increased suction increases the richness of the mixture out of all proportion to the demands of the engine. This is due to an inherent law controlling the flow of air and liquids. It is for this reason that we must have some automatic means of controlling the mixture, such as the air valve, Fig. 15. Then when the mixture grows too rich, the auxiliary air will enter to thin it out and thus automatically the proper proportion of 1 to 15 will be maintained.

Metering Pins. While the theory of the auxiliary air valve is a truly scientific one, it does not serve to make the carburetor entirely automatic over the wide range of speeds and loads which the automobile engine must handle. It is found desirable to hook up what is known as a metering pin, with a throttling action, in many carburetor designs. Sometimes this metering pin action is in connection with the auxiliary air valve, so that both air and gasoline are controlled automatically by the suction which opens the air valve. A device such as this is illustrated in Fig. 16, where it will be seen that the air valve is connected by a short lever to the metering pin, taking the place of the needle valve which was introduced in the simple carburetor arrangement in Fig. 13. The needle in Fig. 13 was manually adjusted by screwing it in or out. The metering pin or needle in Fig. 16 is automatically adjusted by the suction of the engine, which acts on the air valve. When the piston speed, in the device shown in Fig. 16, increases beyond a certain point, the air valve is drawn down. As it is drawn down, the lever pulls the metering pin up. As the metering pin rises, the amount of gasoline passing upward through the gasoline tube is measured in a rather accurate fashion. The farther the metering pin is raised, the larger the amount of gasoline which may flow past it into the cross tube.

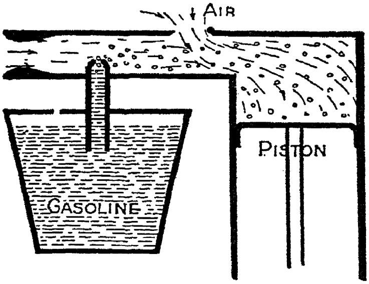


Fig. 14. Additional Air Supply to Prevent too Rich Mixture

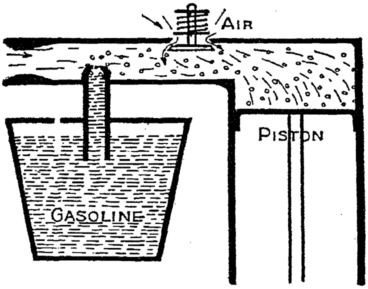


Fig. 15. Automatic Air Valve

It will be seen that by carefully figuring the spring pressure on the air valve and just as carefully and scientifically figuring the size of the metering pin with reference to the gasoline tube and especially by giving attention to the taper of the metering pin, that almost any desired amount of gasoline may be fed into the air stream, depending upon the demands of the engine. It will further be seen that when the exact point at which the air valve will open is reached under certain engine speeds, that the amount of air entering can be figured exactly and then the form of metering pin of the desired characteristics may be used to admit just the right amount of liquid, fuel, or gasoline.

These simple hook-ups shown in Fig. 16 represent the fundamental principles made use of by many carburetor designers and manufacturers. As a general rule, the mechanism is far more complicated than that illustrated, but the principle involved is the same; the idea being that a fuel and air mixture ratio of 1 to 15 must be maintained.

Dashpots. Owing to the peculiar nature of air with respect to its lightness and elasticity, an arrangement or air valve similar to that shown in Fig. 15 is likely to be more or less erratic, that is, the air valve will flutter in and out as the pistons deliver their suction impulses to it. In order to control this tendency to flutter, a dasher is attached to the air-valve mechanism. As a rule, it is somewhat similar to the form shown in Fig. 16, where a metal plate or disc has been fastened to the end of the metering pin. It will be seen that when the air valve tends to flutter, this plate must be moved up and down in the liquid gasoline, which is in the bowl of the carburetor. Any one knows that fluid resists rapid movement of anything through it. This device effectually overcomes the tendency of the air valve to flutter and thus cause an uneven mixture and unevenly operating engine. This is a very elementary design and in actual practice, when looking over carburetors for dashpots and dashers, they will be found in a variety of forms. Generally the

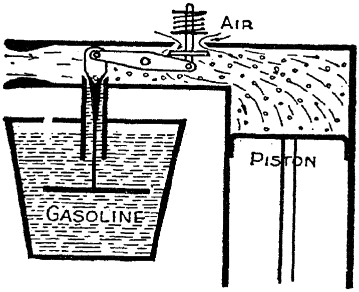


Fig. 16. Automatic Air Valve with Metering Pin and Dasher Attached

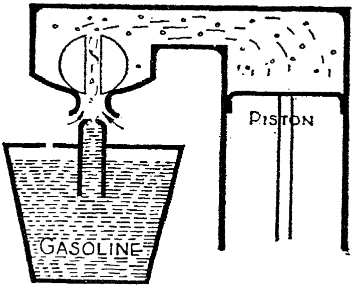


Fig. 17. Ball Used for Air Valve

action of the dashpot is further regulated by the use of small ball check valves.

Pneumatic Control of Air and Fuel Mixture. The sole purpose of a carburetor is to provide a mixture of one pound of fuel or gasoline to fifteen pounds of air, so that the engine may operate evenly under all conditions. It was early learned that the pneumatic principle, that is, gravity in connection with air flow, could be made use of in order to control the fuel mixture within the desired limits. Fig. 17 shows a simple form of carburetor which is somewhat different from the one shown in Fig. 12. It will be noted that the gasoline tube is not connected directly to the cross tube of the device. Instead a small opening has been provided in a recess of the tube, at the bottom. This opening is in the nature of a small venturi. From this opening or venturi, resting on its upper surface, is a ball. This ball has a hole drilled through it. When used as a simple carburetor, it will be found that the engine speed will be steady up to a certain point, when the suction increases and lifts the ball from its seat as shown in Fig. 18. When the ball is lifted from its seat, an additional amount of air is allowed to enter the carburetor. It will be noted that this action is very similar to that of the auxiliary air valve and serves the same purpose of controlling the mixture within the desired ratio. It will be well to make a study of the interesting arrangement of the gasoline tube shown in Figs. 17, 18, and 19, which sets within the bottom of the venturi or opening into the cross tube of the device. It will be noted that the air, in entering the tube, must pass the upper edge of the gasoline tube. As it passes this

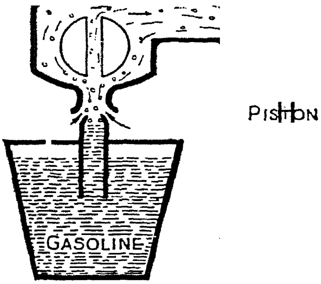


Fig. 18. Suction Lifting Ball in Pneumatic-Principle Carburetor

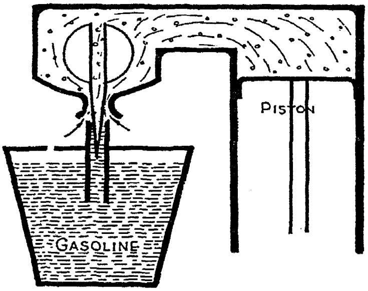


Fig. 19. Metering Pin Attached to Ball Valve

point, it creates the desired suction which draws and lifts the gasoline into the cross tube and on down into the cylinder. It will be seen that the general shape of this opening into the cross tube has much to do with the amount of gasoline which will be drawn from the gasoline tube. This is the device which is used in practically all carburetors, in some fashion or other. It is called a venturi and the gasoline tube is called a gasoline nozzle. The upper end of the gasoline nozzle is always within the lower end of the venturi.

In scientifically-designed carburetors of this type a metering pin is always used in conjunction with the ball, which is always lifted from its seat by the suction of the piston. This is illustrated in Fig. 19, where the metering pin is shown attached to the ball valve. Now it will be noted that as the suction increases and the ball is lifted farther and farther from its seat, more gasoline is allowed to flow from the gasoline tube; so again we have a means of scientifically and exactly regulating the amount of fuel which will enter a given amount of air so that we can maintain the 1 to 15 ratio. This action is entirely automatic, depending altogether upon the speed of the piston and the suction developed by this speed.

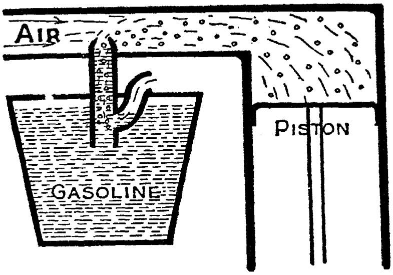


Fig. 20. Air-Bled Gasoline nozzle

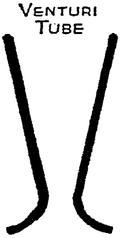


Fig. 21. Venturi Tube
Used to correct flow of air and give a partial vacuum for better vaporization.

Air-Bleed. Referring to the simple carburetor shown in Fig. 12 and then to the modified form shown in Fig. 20, it will be noted that a new method of controlling the amount of gasoline flowing through the gasoline tube has been introduced. This is in the form of an air opening into the gasoline tube so that as gasoline is drawn from the carburetor bowl and mixed with the air passing it, auxiliary air is drawn into the gasoline, passing from the carburetor through the gasoline tube to the cylinder. This is what is termed an air-bleed jet. Instead of a solid stream of gasoline being drawn into the cross tube to mix with the air, air bubbles are drawn with the gasoline from the gasoline tube. These air bubbles serve to break up the gasoline into smaller particles so that the further action of the air upon them results in better atomization and a better fuel mixture.

There are a number of carburetors on the market which make use of this principle. Very definite scientific laws are known with reference to the flow of both liquid and air. By controlling the openings for air and fuel or by controlling what is known as the size of the tubes used in these carburetors, it is possible to have carburetors designed and manufactured which maintain the ratio of 1 to 15 without the use of any mechanical means, such as the metering pin or the auxiliary air valve.

Venturi Tube. It has long since been learned that air may be passed through a tube, the form of a venturi tube, shown in Fig. 21, with great ease and when so passed will develop certain desired results. The problem in carburetor design is to secure the proper suction from the gasoline needle at slow speeds and then at the same time to permit enough air to enter at high speeds so that the desired ratio of air and fuel may be maintained. The venturi tube lends itself to this combination of several extremes. Fig. 21 shows a cross section of such a tube and it will be found in all cross sections of carburetors shown in this book. Fig. 22 shows a simple carburetor which makes use of the principle of the venturi tube. The nozzle in this case is located in the venturi tube, much after the fashion of all venturi tube and gasoline tube construction. It will be noted that as the piston descends into the cylinder and suction is set up around the nozzle where it is placed in the lower part of the venturi, air enters the venturi and picks up the gasoline as it passes.

Vacuum has a very decided effect upon vaporization. Due to the peculiarity of the construction of the venturi tube, it tends to produce a partial vacuum in its upper end when air is drawn through it. It will be noted, of course, that the lower part of the venturi tube is constricted and the upper part is opened wide. Air, passing through at a fixed speed, is more or less confined at the small part of the venturi and then expands to fill the upper end of the venturi, with the result that a partial vacuum is secured. Owing to the suction of the piston and the restriction of the flow of air at the smaller part of the venturi, all carburetors are provided with what is termed a mixing chamber. This mixing chamber is always located above the gasoline nozzle and close to the upper part of the venturi. A partial vacuum exists in the mixing chamber and just as water may be boiled more readily in a vacuum than it may be under normal air pressure, so the gasoline tends to vaporize more readily in this partial vacuum.

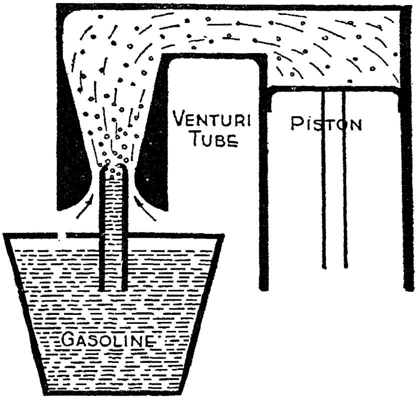


Fig. 22. Cross section of Venturi Tube with Gasoline Nozzle as Used in Carburetor Design

Heat. As was explained and illustrated in Fig. 5, it is easier to vaporize fuel by adding heat to it. In the average carburetor, heat is picked up by the air as it enters or it is supplied by providing a combination exhaust and intake manifold which results in what is termed a "hot spot." The hot spot is nothing more than a thin metal wall between the exhaust and intake manifolds. When the globules of gasoline or fuel strike this hot spot, they are steamed and vaporized. The use of the combination manifold is meeting with more favor with carburetor manufacturers than the use of the hot-air stove, which at one time was considered the best means of heating the mixture. The change is the result of the different methods used in refining gasoline. In other words, gasolines used today are not so volatile (easily vaporized) as they were formerly. The hot spot, which becomes heated to a very high temperature, acts in a better fashion than the heat picked up by the air as it would pass through a hot stove on the way to the carburetor.

Another objection to the use of the hot stove is the fact that air, once it has been heated, expands very rapidly and less expansion is left to the air after it enters the carburetor and the full effect of the vacuum is not secured in the mixing chamber. Frank Lockhart made a very real contribution to carburetor design when he discovered that air expanded so rapidly from heat on his racing cars that it was necessary to re-cool the charge before it entered the cylinders.

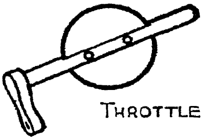


Fig. 23. Throttle Valve with Control Attached

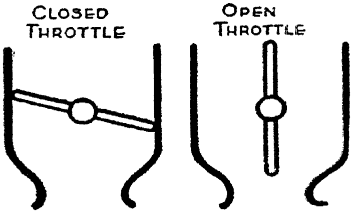


Fig. 24. Open and Closed Throttle as Illustrated in Conventional Drawings

Throttling the Car. The butterfly throttle is used in all carburetors for controlling car speed. This is a relatively simple device and is illustrated in Fig. 23. When the foot accelerator is depressed, the throttle is first cracked or opened very slightly and then gradually opened to its full open position. Closed and open positions for the throttle are illustrated in Fig. 24. When starting an engine, it is desirable to have the throttle closed or almost closed. The reason for this is that the engine is turning very slowly and no considerable vacuum is secured if the throttle is opened any great amount. In other words, vacuum is desired and necessary if gasoline is to be raised from the carburetor bowl to the mixing chamber and then carried through the intake manifold to the engine. The distance it is lifted will vary in different cars, but it will fall within the limits of 4 to 10 inches usually. Very often carburetors are provided with a special starting jet, which is placed just above the edge of the throttle valve, as shown in later figures. This jet passes a sufficient amount of gasoline to provide for starting but immediately the throttle valve is opened, the suction on this jet drops to such an extent that it shortly ceases to function and no more gasoline is drawn through it. This feature, which is used to secure easy starting, is incorporated in a number of carburetors.

Not infrequently certain mechanical arrangements are provided in connection with the action of the throttle or butterfly valve. Sometimes the arrangements are hooked on to the control rod on the outside of the carburetor and at other times they are hooked on to the butterfly valve which is always within the mixing chamber. When these devices are hooked on the opening of the throttle, certain levers which control air valves, metering pins, and dashpots are set into motion in such fashion that the desired mixture of 1 to 15 is secured in a rather mechanical fashion. Naturally mechanical designs of this nature are worked out in a very exact way. Wear, which is the result of vibration and use, may put these mechanical devices out of balance with the result that a carburetor cannot be adjusted to perform properly. This is particularly true with carburetors on cars which have seen many miles of service. The method of repair, of course, is obvious. The worn parts must be replaced and the new ones properly set and adjusted.

Carburetor Floats and Bowls. Although there is a tendency to get away from the carburetor float, they are used in most instances. The purpose of the bowl is to provide a reservoir of fuel from which the supply used by the engine may be drawn. The purpose of the float is to regulate the level of the fuel within the bowl. While on the face of it the float and bowl are relatively simple, they play a very important part in the actual ratio of fuel mixture. The level of the fuel within the bowl has been calculated in a very exact way. The float needle and float have been designed to maintain this level, which is usually just a little bit below the upper end of the gasoline needle where it is placed in the lower end of the venturi. Naturally the nearer the level may be to the top of this tube, the easier it will be to draw gasoline from the reservoir or carburetor bowl. It will therefore be seen that if the setting of the carburetor float and needle valve are changed by accident or any other reason, "spitting" of the carburetor may result on the one hand and on the other hand the level may be so low within the carburetor bowl that it is practically impossible to start the engine or to adjust the carburetor to secure a smooth running engine. Most carburetor manufacturers give specifications for the upper level of the gasoline within the bowl in relation to the upper end of the gasoline needle.

Fig. 25 shows the principle of the carburetor bowl and float. Gasoline entering from the feed line passes the needle valve and, as the gasoline fills the bowl, the float rises on the gasoline and by means of the level so forces the needle valve down into the valve seat on the end of the gasoline feed line, thus shutting off the flow of gasoline until such time as the engine has drawn some gasoline from the carburetor bowl and more gasoline is needed.

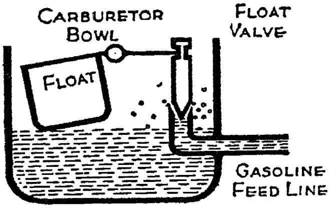


Fig. 25. Principle of Carburetor Float and Bowl

Needle Valves. Needle valves—or spray nozzles as they are sometimes called because of the function they perform—constitute an important part of every carburetor or liquid-vaporizing device. It might be thought that so long as there is a hole by which the fuel can enter the vaporizing chamber that is sufficient; yet such is far from the case. In addition to the function of an entering hole, the needle has the additional duty of breaking the fuel up into a fine spray or mist, the particles of which are easily picked up by the inrushing air and as easily converted into a vapor. Therefore, that shape, form, or arrangement which will divide the entering liquid up into the finest particles will be the most efficient. The difference of opinion on this latter point has produced the large number of shapes of nozzle and needle which are now in use. In general, practically all these can be divided into four groups, illustrated in Fig. 26.

The simple vertical tube at *A* is a round vertical tube with an opening in the top through which the liquid may pass out. It does not alter the type if the sides of the opening converge, diverge, or are straight, but it will influence the resulting spray somewhat.

Type *B*, Fig. 26, is similar to the first, except that an adjustable pointed needle is added on the inside. This occupies most of the center space, forcing the liquid to pass out in a smaller circular sheet or stream than would be the case with Type *A*, considering equal-sized holes. In addition, the fact that the internal needle valve may be raised or lowered allows this stream to vary greatly, both as to quantity of fuel flowing and the extent to which it is spread out. When the needle is down very low, only its point enters the hole, so that practically the full area of the latter is available, the central needle influencing the column of fuel passing out only to make it hollow in the center.

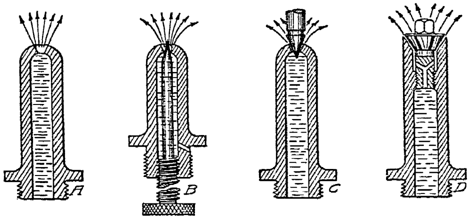


Fig. 26. The Four Usual Shapes of Gasoline Needle Valves and Spray Nozzles

With the needle raised to nearly its maximum height, however, the point projects clear through, and the needle shaft almost fills the lower part of the hole This reduces the flow to a very fine hollow column of spray, as the shape of the needle and of the lower edge of the hole is such as to force it inward and then outward so that as it leaves the top of the hole it is diverging widely. Thus the effect of the addition of the needle is to allow the use of much smaller quantities of liquid with the same-sized hole, of diffusing it more widely, and of making it adjustable to varying needs. Despite all its advantages, only three of the carburetors and vaporizers shown use this type; and of these, one is a combination of this with *A*.

The third type shown at *C*, Fig. 26, is an inversion of *B* in that the needle is made external and descends from above into the hole in the nozzle. In this form, the shape of the needle point produces the desired diffusion and spraying effect, which accounts for its position.

The fourth form, shown at *D*, is like *C* except that instead of a needle resting upon the upper surface of the hole and allowing a continuous hollow stream of fuel to flow, a series of holes break up the column into a number of very much smaller columns, each with its own opening. In this form the central member may be movable or not, while the holes may be set at any angle. Of the examples of this form, every one has the holes placed horizontally instead of inclined to a vertical, as shown in Fig. 26. Of these, two show a combination of *B* and *D*, which is an effective combination.

ZENITH CARBURETORS

Underlying Principles. Zenith carburetors are designed to operate on the "balanced ration" principle. It means that no matter what the speed of the engine, there is a fixed ratio of air and fuel available for consumption within the combustion space. While the suction of the engine and the vacuum thus created varies with the speed of the engine and while the fuel required varies with the speed, the proportion of gasoline to the cubic foot of air must not vary if the carburetor is to perform properly and carry the load at varying speeds.

The Zenith method of securing the balanced ration, or fifteen pounds of air to one pound of gasoline, with the widely varying engine speeds and conditions of vacuum, is what is known to scientists as the Bavery principle. It is named for the French scientist, M. Bavery, who invented the Zenith carburetor.

Natural laws are made use of in this plain tube carburetor. There are no moving parts such as air valves, levers, etc. In Fig. 27 a small venturi has been provided at the opening of the air tube so when the piston travels downward, air is drawn through the venturi, past the gasoline nozzle, from which gasoline is drawn. Both the venturi and the gasoline tube have fixed openings. This is the condition mentioned as providing an increasingly rich mixture. It would be satisfactory for a fixed engine speed with fixed loads, but as the engine picks up speed the mixture grows too rich.

A method of doing away with this type of tube and supplementing another is illustrated in Fig. 28. Instead of a tube at the top of the gasoline bowl, a fixed opening has been provided at the bottom of the gasoline bowl. The gasoline flow from this fixed opening drops into the bottom of a well, from which point it is picked up by the suction of the engine and carried up through the plain tube. It will be seen that this well is provided with an opening at the top. No more gasoline can be drawn from the well than flows through the fixed opening into it. Air will be drawn through the plain tube along with the gasoline.

It will be readily understood that a device of this kind could be arranged to operate an engine at, say 500 r.p.m.; but if the speed of the engine were increased to 1000 r.p.m., there would be a decided shortage of gasoline since the mixture would grow leaner and leaner as the engine speed increased. The reason for this is that there is no suction whatever upon the amount of gasoline flowing from the gasoline bowl. This, it will be seen, is just exactly opposite that illustrated in Fig. 27, where the mixture grew richer and richer.

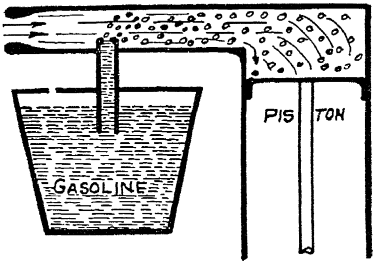


Fig. 27. The piston descending in the cylinder draws liquid fuel from the plain nozzle.

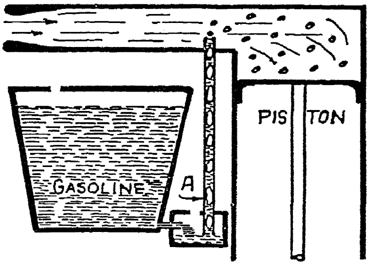


Fig. 28. The piston descending in the cylinder draws air and liquid fuel from the tube *A*.

In order to provide a carburetor which is entirely automatic in operation, these two principles illustrated in Figs. 27 and 28 were combined in Fig. 29. Air enters through the small venturi as the engine picks up speed. The mixture coming from the plain tube at the top of the gasoline bowl becomes richer and richer. Suction is also drawing gasoline up from the well through the tube *A*. This mixture grows leaner and leaner. As these two mixtures are mixed together, a very satisfactory mixture is secured for all engine speeds. In other words, the enriching features of the first plain tube arrangement are offset by the leaning of the second plain tube arrangement so that they compensate for each other and the engine may be operated at any speed whatever with a very satisfactory fuel mixture. Naturally the calibration of the openings must be very accurate, considering the size of the engine to be handled. For this reason carburetors are not interchangeable over a wide range of engines. A carburetor is designed for some specific engine and performs with greatest satisfaction on that one engine. If it is changed to another engine, then the nozzles which control the openings in the fixed tubes must be changed and not infrequently the venturi or the carburetor throat must also be changed.

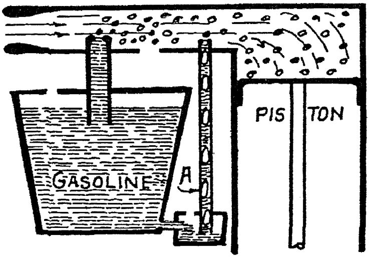


Fig. 29. The piston creates suction which acts on both tubes or nozzles and the mixtures unite with each other.

Zenith Design. Fig. 30, while being similar to Fig. 27, shows a section more nearly that of the standard carburetor. It shows the throttle, mixing chamber, the plain gasoline nozzle in the venturi, the gasoline bowl with a float control, and other features of carburetor construction. The throttle in this case is set at a wide-open position. It will be noted that a very great amount of gasoline has been drawn out and, as in Fig. 27, the tendency is for the mixture to become too rich. Note the globules of gasoline above the gasoline jet *G* in the venturi *X*.

In Fig. 31 the opposite arrangement is shown. It compares with that in Fig. 28. A calibrated opening shown at *I* allows the gasoline to drop into the well *J*. The well *J* is open to the air and as the suction of the engine increases, owing to increased speed, the mixture shown flowing from the nozzle *H* becomes more and more lean and it is mixed with the air in the venturi *X*. Again the throttle is shown in wide-open position. Neither the arrangement shown in Fig. 30 nor that shown in Fig. 31 will give a balanced ration.

In order to secure this balanced ration, it is necessary to combine the arrangement shown in Figs. 30 and 31, as shown in Fig. 32. Gasoline enters the bowl *F* and flows through the tube and nozzle *G* into the bottom of the venturi *X*. A certain amount of gasoline flows through the fixed opening *I* into the bottom of the well *J* and rises into the tube *H*, which is around the tube *G*. Now it will be seen that as the engine is throttled and the speed increases, the center nozzle gives a mixture that is too rich and the outer nozzle gives a mixture which is too lean. The gasoline and air mingle in the mixing chamber *X* and an ideal mixture is secured for operating the engine at all speeds.

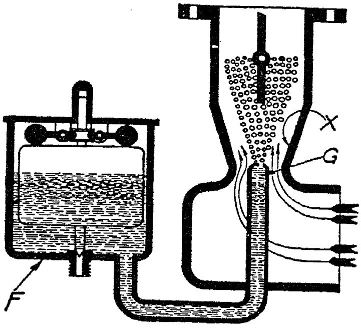


Fig. 30. Section of simple carburetor with one plain tube. The mixture grows too rich.

The Zenith 150 Series Carburetors, Fig. 33, are used on passenger car, truck, bus, taxicab, industrial and farm equipment, wheel tractors, and marine engines.

Carburetor Operation. The Zenith compound nozzle system of carburetion is used in all models. This consists of two jets—the main jet, directly connecting the fuel in the bowl with the air stream

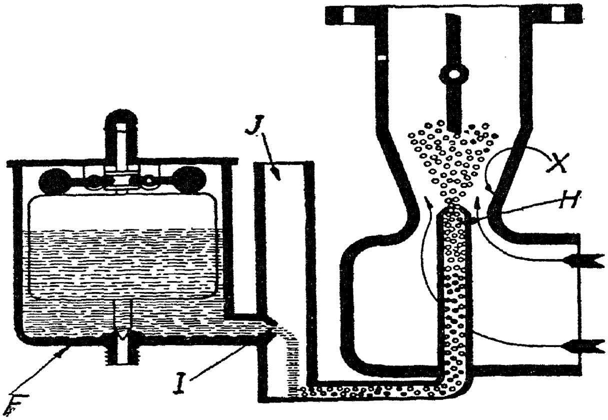


Fig. 31. Section of a simple carburetor, with a plain tube set into a well, fed by a calibrated opening. The well *J* is open to the air. Mixture grows too lean.

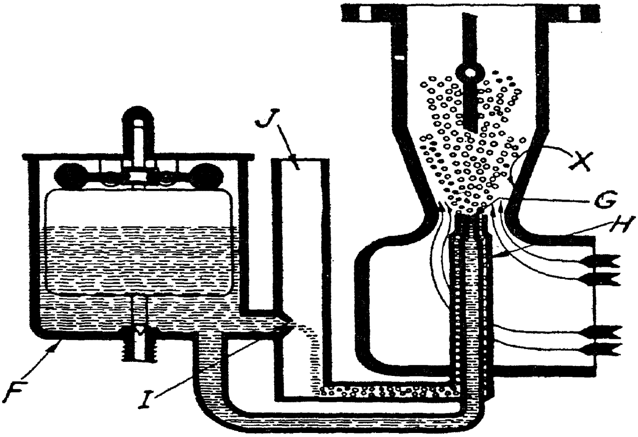


Fig. 32. The two plain tubes are combined in one compound nozzle. The nozzles supplement each other to give a proper mixture at all engine speeds without resort to moving parts.

in the carburetor barrel through the main jet discharge tube, Fig. 34, and the compensating jet flowing into an open well and connected with the air stream through the supplemental jet.

The main jet flow varies with suction, delivering more fuel as the engine speed increases, thus its tendency is to richness at top engine speed. The compensating jet is not affected by suction, therefore, it flows the same at all speeds and has a tendency to leanness at top engine speed. In combination, the rich and lean jets give an average mixture of correct proportion.

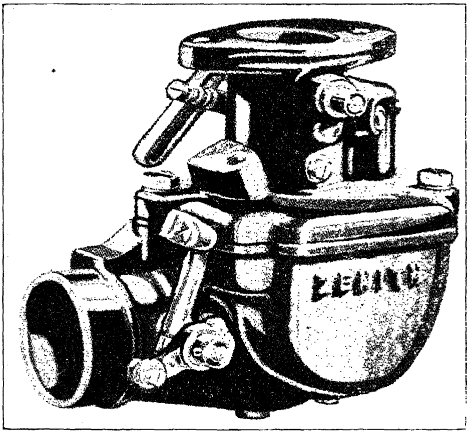


Fig. 33. Zenith 150 Series Up-Draft Carburetor
Courtesy Zenith-Detroit Corporation

Idling. The idling system functions only on starting and idling. When the throttle is opened past the idling position, the fuel goes the other way through the discharge tubes and the idling system is automatically out of operation. It consists of an idling jet and tube to supply the fuel, an idling needle valve to correct the idling mixture, and a channel to carry the mixture into the carburetor barrel at the edge of the throttle. The desired idling speed is set by the stop screw on the throttle lever.

Full Power and Acceleration. Full power, either for top speed or hard pulling, requires a richer mixture than part throttle operation. So does acceleration. This additional richness of mixture is provided by combined accelerating and economizing systems operated by the vacuum above the throttle valve. There is a plunger pump to force fuel into the air stream, a check-valve to prevent fuel from being forced back into the fuel bowl, and an economizer valve to control the additional fuel flow. The suction above the throttle holds the pump at the top of the pump well when the throttle is partially closed. As the throttle is opened the suction decreases, releasing the pump which drops to the bottom of the well, forcing fuel ahead of it. The economizer valve, Fig. 35, is opened as the pump nears the bottom of the well. This opens a passage for the accelerating charge and also for the additional ration of fuel necessary for full speed or power if the throttle is held open.

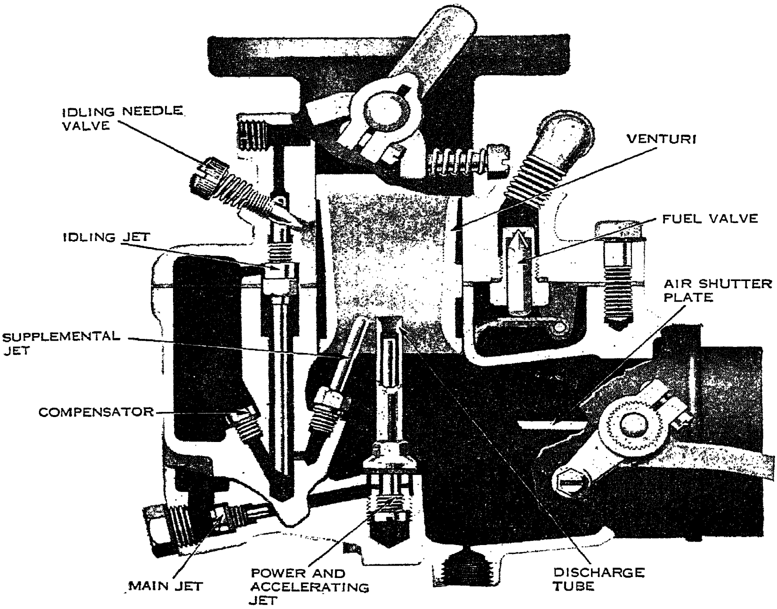


Fig. 34. Sectioned View Zenith Series 150 Carburetor
Courtesy Zenith-Detroit Corporation

Economy. As the throttle is closed, the pump is lifted by the increased suction, so that the fuel flow is reduced for anything less than full-load operation. This vacuum type accelerating and economizing system may be used to advantage with a governor. In this case the carburetor throttle valve is usually wide open, the speed being controlled by the governor valve. By "bridging" the governor with a suction line, the pump is actuated by the suction above the controlling governor valve and economizer action is thus retained.

Starting. The idling system acts as a priming device when the engine is at rest because the idling jet is submerged in the fuel that fills the well. The throttle should be slightly opened as this results in a very strong suction on the idling jet. The fuel passing at high velocity over the edge of the throttle plate is finely atomized and the high vacuum instantly vaporizes and mixes it with the air. This will ensure the first few explosions. With the usual manually-controlled strangler it is sometimes difficult to keep the engine running. To overcome this, Zenith uses a spring-loaded strangler.

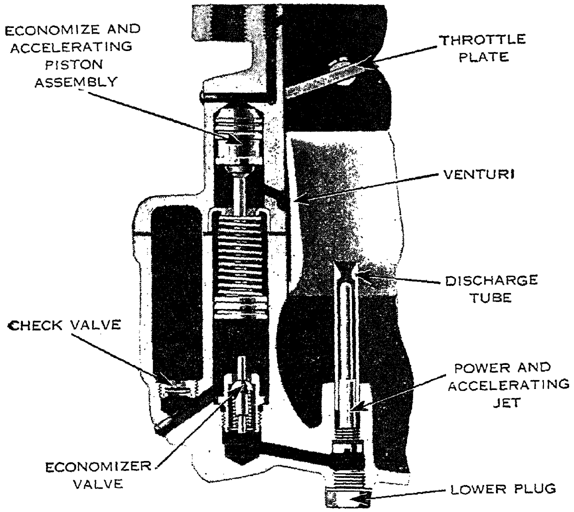


Fig. 35. Sectioned View of Zenith 150 Carburetor showing Accelerating Pump
Courtesy Zenith-Detroit Corporation

The strangler shaft is off center so that the engine suction tends to pull it open. A spring tends to pull the strangler shut, but, except at cranking speeds, the spring is the weaker of the two forces. Accordingly, as the engine is speeded up or slows down the strangler opens and closes, always being in a position to deliver just the right amount of air. This prevents over-choking and crank-case dilution and ensures continued running even in the coldest weather. Cold-room tests at zero temperature and experiences in the open air indicate that a car can stand all night at zero and be started and driven away with the engine firing regularly in less than half a minute. The strangler control is pulled out as usual for starting. It is left in this position or pushed in slightly until the engine warms up, then pushed in to the open position. No "jiggling" of the control is necessary.

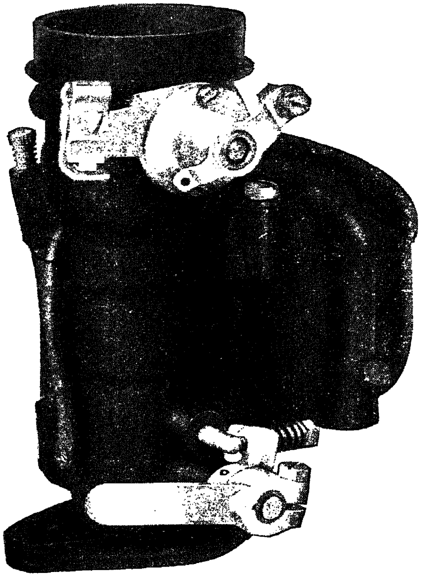


Fig. 36. Zenith Down-Draft Carburetor
Courtesy Zenith-Detroit Corporation

ZENITH DOWN-DRAFT CARBURETORS

Model "IN-175." The Zenith compound nozzle system is used in the Model "IN-175" carburetor, Fig. 36. This consists of two jets, the main jet and the compensating jet. (See Fig. 37.) The main jet varies with suction. Its tendency is to richness at top engine speeds. The compensating jet, unaffected by suction, has a tendency to leanness at top engine speeds. In combination, the rich and lean jets give an average mixture of correct proportions.

Carburetor Operation. An idling jet meters the fuel for idling while an idling adjusting needle controls the air. The idling tube carries this mixture to the discharge opening at the edge of the throttle plate. Idling speed is regulated by the throttle stop screw, Fig. 38.

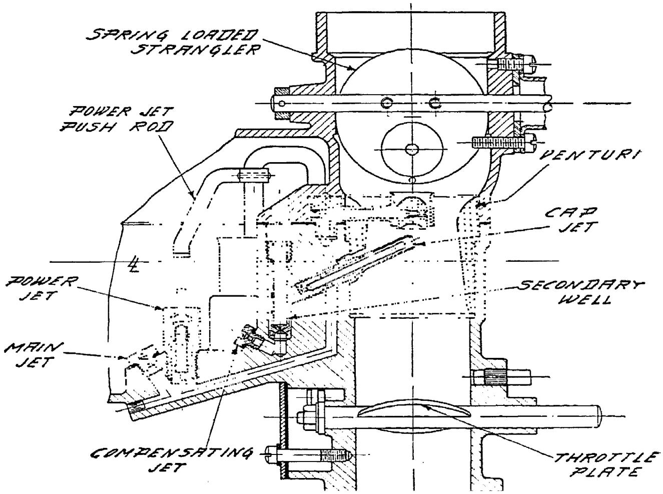


Fig. 37. Zenith Model IN-175 Mains and Compensating Jets
Courtesy Zenith-Detroit Corporation

Because full power requires a richer mixture than part throttle operation, the added fuel is provided by the power jet. The power jet valve is opened by the power jet push rod when the throttle is wide open. As the throttle closes from wide-open position, the push rod raises, thus permitting the valve to close and insuring economical metering for part throttle running. (See Fig. 39.)

Acceleration is provided for by a pump which is controlled by the movement of the throttle. The downward stroke of the pump piston forces fuel from the pump cylinder into the air stream through the accelerating discharge opening. This furnishes the necessary additional fuel for flashy acceleration. (See Fig. 39.)

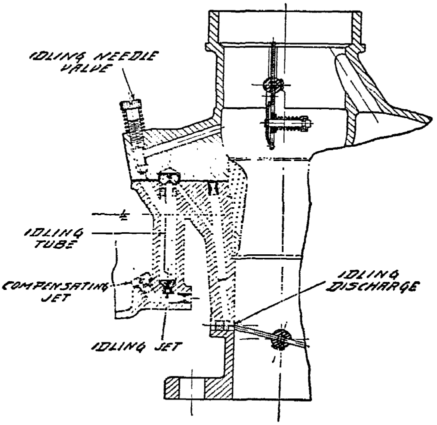


Fig. 38. Idling Position of Throttle
Courtesy Zenith-Detroit Corporation

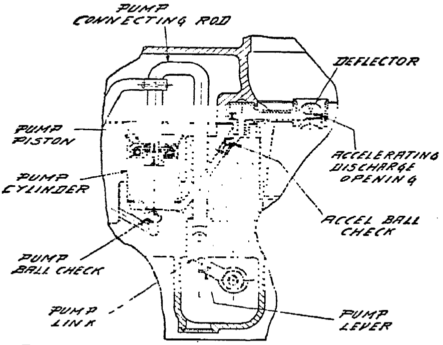


Fig. 39. Power Jet and Accelerating Pump, Zenith Model IN-175
Courtesy Zenith-Detroit Corporation

Starting. In starting the idling system acts as a priming device. With the throttle only slightly opened, there is a very strong suction on the idling system. Fuel passes at high velocity over the edge of the throttle plate and is instantly vaporized as it mixes with the air stream. It is especially important to avoid over-choking in down-draft carburetion. Zenith uses a strangler with a by-pass valve which opens or closes with varying engine speeds, furnishing a combustible mixture until engine temperatures permit opening the strangler. The strangler shaft is off center so it may be satisfactorily operated by the automatic choke assemblies now used on many cars.

The fuel level should be $\frac{45}{65}''$ from the top edge of the float chamber when the carburetor is tested with $1\frac{1}{2}$ pounds pressure (equivalent of 6′ head). The chart of approximate settings provides the dealer with a jet combination to use in the absence of settings determined by actual road test. When a main jet adjustment is used, a main jet two sizes smaller should be used.

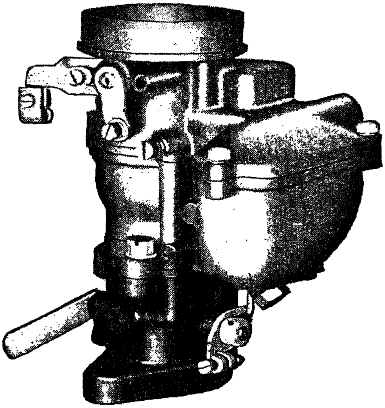


Fig. 40. Zenith IN-180 Down-Draft Carburetor
Courtesy Zenith-Detroit Corporation

"IN-180" Series Carburetors. The Zenith "IN-180" Series carburetor, Fig. 40, has been especially designed to meet every condition encountered in down-draft carburetion. This includes provisions in design that insure positive, smooth idling, elimination of over-choking, and other difficulties already known to many users of down-draft carburetors.

The carburetor is a fully balanced down-draft instrument, incorporating an enclosed mechanical accelerating pump and vacuum (or mechanical) economizer system, a special float construction, and other important features. Dirty air cleaners do not affect the mixture ratio. Marked accelerative ability, smooth operation, great range, flexibility, and, generally, fine operating characteristics are secured.

Carburetor Operation. The Zenith compound nozzle system is used. This consists of two jets, the main jet and the compensating jet as shown in Fig. 41. The main jet varies with suction. Its tendency is to richness at top engine speed. The compensating jet, unaffected by suction, has a tendency to leanness at top engine speeds.

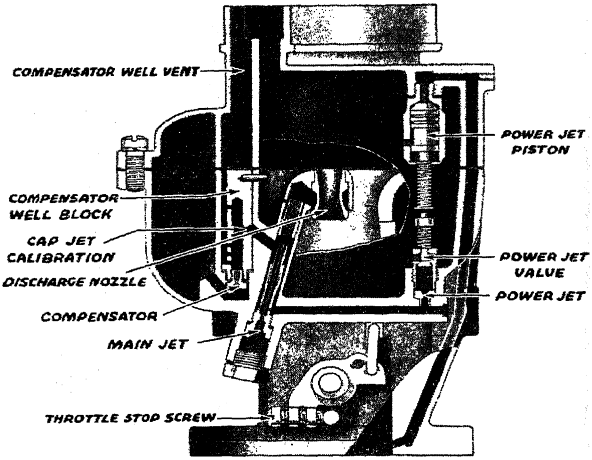


Fig. 41. Sectioned View Model IN-180 Zenith
Courtesy Zenith-Detroit Corporation

In combination, the rich and lean jets give an average mixture of correct proportions. To these a power jet is added which operates only when extra fuel is needed for development of maximum power. Under part throttle the suction (or vacuum) on the manifold side of the throttle is higher than when the throttle is wide open. This suction holds up the power jet piston assembly, permitting the power jet valve to remain closed, thus shutting off fuel from the power jet.

When the throttle is opened, the suction decreases, thus permitting the power jet piston to be opened by the pressure of its spring. The falling piston opens the power jet valve, permitting fuel to flow to the power jet which is of a size to measure only enough additional fuel to develop full power.

Acceleration (see Fig. 42) is provided for by a pump which is controlled by movement of the throttle. The downward stroke of the pump piston forces fuel from the pump cylinder into the air stream through the accelerating jet. This furnishes the necessary additional fuel for flashy acceleration. An air vent controlled by a ball check valve, is provided between the pump and discharge opening, to prevent the accelerating jet from supplying fuel except during the downward movement of the piston.

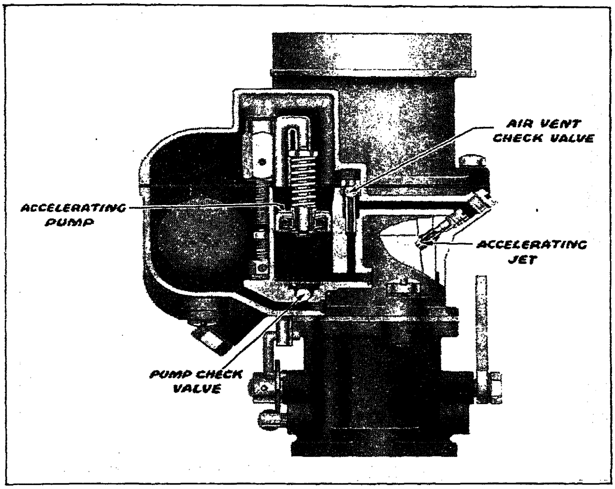


Fig. 42. Accelerating Pump and Float Chamber
Courtesy Zenith-Detroit Corporation

An idling jet, Fig. 43, meters the fuel for idling while an idling adjusting needle controls the air. The idling tube carries this mixture to the discharge opening at the edge of the throttle plate. Idling speed is regulated by the throttle stop screw.

In starting the idling system acts as a priming device. With the throttle only slightly opened, there is a strong suction on the idling system. Fuel passes at high velocity over the edge of the throttle plate and is instantly vaporized as it mixes with the air stream.

It is especially important to avoid over-choking in down-draft carburetion.

Zenith uses a strangler with a by-pass valve which opens or closes with varying engine speeds, furnishing a combustible mixture until engine temperatures permit opening the strangler. The strangler shaft is off center so it may be satisfactorily operated by the automatic choke assemblies now used on many cars.

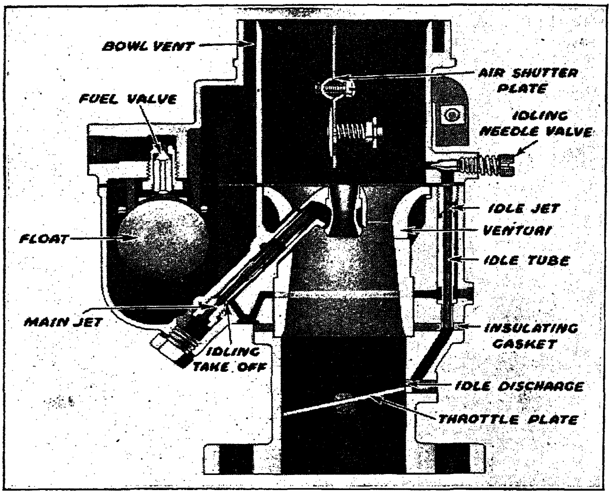


Fig. 43. Idling Tube, Needle and Throttle
Courtesy Zenith-Detroit Corporation

OLDSMOBILE 8=STROMBERG "EE=1" CARBURETOR

Main Metering System. Fuel enters the carburetor at the gasoline inlet *10*, Figs. 44 and 45, flowing through the float needle valve and seat *7-8* into the float bowl. Here it is maintained at constant level by float *6*. Air, which enters the carburetor through the air entrance at the top, places suction on the main discharge jet *3*, or idle discharge holes *14*, depending on the amount of throttle opening. The main metering jets *12* are of the fixed type. They control the flow of gas during the intermediate speeds of part throttle position up to approximately 75 miles per hour. From the metering jets the fuel passes into the main discharge jet *3*, where it is mixed

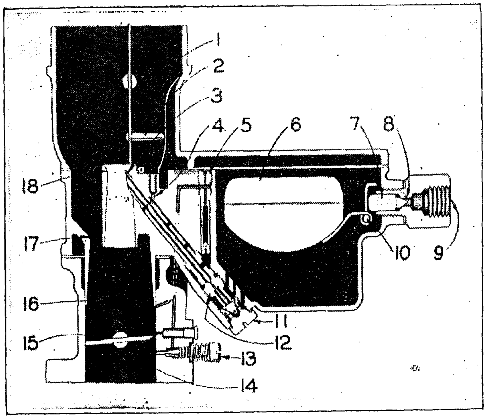


Fig. 44

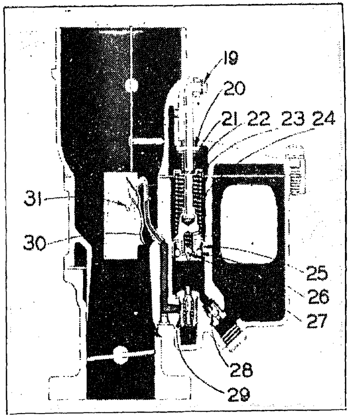


Fig. 45

OLDSMOBILE CARBURETOR

PARTS INDICATED IN ILLUSTRATIONS ABOVE ARE AS FOLLOWS:

1. Choke Valve
2. Choke Valve Stop Pin
3. Main Discharge Jet
4. High Speed Bleeder
5. Idle Air Bleeder
6. Float
7. Float Needle Valve
8. Float Needle Valve Set
9. Gasoline Inlet
10. Float Fulcrum Pin
11. Main Discharge Jet Plug
12. Main Metering Jet
13. Idle Needle Valve
14. Idle Discharge Holes
15. Throttle Valve
16. Mixing Chamber
17. Primary Venturi
18. Auxiliary Venturi
19. Pump Piston Link
20. Dust Washer
21. Dust Washer Spring
22. Spring Retainer Lock
23. Spring Retainer Washer
24. Pump Duration Spring
25. Pump Piston
26. Pump Piston Expansion Spring
27. Pump Relief Valve
28. Pump Inlet Check
29. Economizer By-Pass Valve
30. Pump Discharge Nozzle Holder
31. Pump Discharge Nozzle

IMPORTANT: When ordering venturi tubes, high speed bleeders, metering jets, main discharge jets or by-pass jets, etc., specify the size required, and always state type of carburetor with serial number; also the model and make of the car for which the part is intended.

with air from the high speed bleeder *4,* and then flows into the carburetor barrel, down to the intake manifold.

When the car reaches the speed of approximately 75 miles per hour, a richer mixture is required than that necessary for normal throttle opening. At this speed economizer valve *29* is forced down by piston *25,* allowing gas to flow through the economizer valve and discharging through restriction *31.* All gas from the economizer is controlled by this restriction.

All jets of the fixed type are calibrated at the factory to supply the correct mixture for normal operating conditions and should not be changed without special instructions. Fuel for idle speeds is drawn through the idle tube into a passage where it is mixed with air from the idle air bleeder *5.* It is then discharged through the idle holes *14,* depending on the amount of throttle opening.

Low Speed or Idling Adjustment. Allow the engine to warm up until the throttle returns to slow-idle. Idle needle valves *13,* Fig. 44, control the gas for low-speed adjustment. Turning OUT the needle gives a richer mixture, and turning it IN a leaner mixture. Turn the inner idling adjustment (the one toward the engine) in slowly until the engine begins to lag or run irregular, then slowly turn out until the engine begins to roll. Finally, turn in the adjustment very slowly again just enough so that the engine runs smoothly for this throttle opening. This adjusts the mixture to the four cylinders which are fed by the inner carburetor barrel. Adjust the outer idle adjustment so that its four cylinders fire smoothly. It may be necessary, after completing this adjustment, to cut down the engine speed slightly.

Accelerating Pump. For smooth rapid acceleration and flexibility, it is necessary to supply momentarily an extra amount of gas when the throttle is opened. On the up stroke of piston *25,* Fig. 45, gas is drawn through the inlet check valve *28,* into the pump cylinder. On the down stroke the compression closes the check valve *28* and forces open economizer valve *29.* The fuel is then discharged through the pump discharge nozzle *31,* into the carburetor barrel. When the throttle is opened part way, only a small amount of fuel is discharged. However, when the throttle is continuously held fully opened, gas flows steadily through the restriction. This gives the richer mixture that is required for maximum power.

Fuel Level. As previously stated, the fuel level in the float bowl is maintained by float *6*. The level is set at the factory at $\frac{15}{32}''$ below the surface of the float bowl. It is not necessary to change this unless extremely high test gas is used, or the carburetor is handled roughly. When necessary, it can be corrected by bending the float arm where it meets the float up or down to give the desired position.

STROMBERG PLAIN-TUBE CARBURETORS

The Stromberg engineers have always held to the plain-tube design in their product, the reason being, as they put it, that the carburetor when set up has the great advantage of "staying put" and maintaining efficient service over a long period.

In the plain-tube carburetor, the mixture proportion is maintained through the combination of the enriching and leaning characteristics of tube design. The double venturi arrangement, long popular with this carburetor, embodies the clean unobstructed form of air passage and gives a full range of high road speed with low-speed pulling ability. It is also designed to give an absolute maximum in torque at any average driving speed. The air-bled jet construction is responsible for the accurately governed fuel mixture through all speed ranges. This principle also gives good atomization and an even distribution of the fuel through the air stream.

The accelerating devices are the result of long seasons of experimenting and years of study of service conditions.

The idling operation of the carburetors is smooth and positive. The idling adjustments may be made without disturbing the high-speed range.

Warming-up controls have been the subject of much study, which has resulted in new devices which give a good range of engine flexibility and smoothness.

Steady Load and Acceleration. The demands placed on a carburetor vary considerably throughout the range of engine speeds and load conditions. The carburetor action which is satisfactory for average driving speeds is not the best possible arrangement for quick acceleration. Economy of gasoline at the average driving speed is secured by using a minimum amount of fuel. On the other hand, rapid acceleration may only be secured by using a richer mixture made available simultaneously with the depression of the accelerating pedal. These conditions should be kept in mind when making a study of the simple sketches which are presented herewith.

When the student mechanic comes to a consideration of the actual carburetor models, both the requirements for driving at a steady rate under average conditions and the requirements for acceleration will be given consideration. The principles of the Stromberg plain-tube carburetor, as outlined here and illustrated in Figs. 46 to 54, deal only with the average operating conditions. The action of a plain tube is illustrated in Fig. 46. It will be noted that a venturi is in position over a plain jet, which is supplied with gasoline from a simple carburetor bowl. When the engine is in operation, the action of the pistons provides suction over the jet, with the result that the globules of fuel are drawn from the jet into the venturi tube. An arrangement such as the one illustrated in Fig. 46 might be so designed as to give fairly satisfactory operation over a speed of about 16 miles per hour and upward, but when the throttle is closed down to a slow engine speed—say below 15 or 16 miles per hour—the mixture will grow lean so rapidly that the engine will slow down and stop.

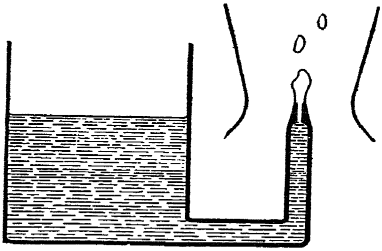


Fig. 46. Globules of Gasoline Will Be "Torn" from the Jet at Slow Speed

For instance if it were desired to have the engine operate at a speed of 10 miles per hour, the fuel jet would have to be increased 50 per cent in capacity. This would result in a corresponding increase in fuel delivery from 15 to 16 miles and upward. It will also be found that it is impossible to have the engine idle properly no matter what the adjustment, because of the fact that the suction in the carburetor at extremely low speed is so weak that the fuel will not be lifted from the jet to the throttle. In order to prevent fuel overflowing at the jet it is necessary to design the float and needle-valve arrangement so that it will always stand at a level slightly below that of the top of the jet. This means that the amount of suction required to lift the fuel from the jet is considerable. At low engine speeds the fuel is likely to come out of the jet in large globules or drops.

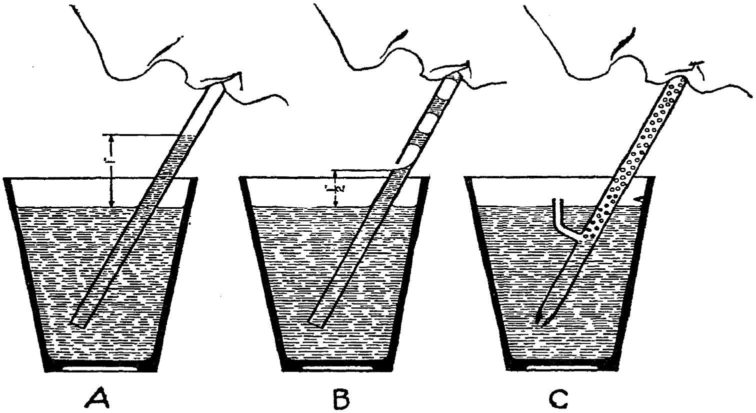


Fig. 47. Principle of Air-Bleeding a Jet

Action of Air-Bleed. The Stromberg application of the air bleed is illustrated in Fig. 47 at *C*. Just as a boy will use a straw to draw milk from a glassful, as shown at *A*, so may the carburetor action be considered. It will be noted that at *A* the fuel is being drawn without any air. However, if a small hole is placed in the straw, as shown at *B*, it will be noted that the same suction as before allows bubbles to enter and the milk will be drawn upward in a continuous series of drops. At *C*, illustrating the air-bleed principle, it will be noted that an additional tube has been set into the original tube or straw at a point somewhat below the top surface of the fluid. Suction on the tube now introduces a considerable quantity of air along with the fluid. Since the lower end of the tube has been restricted, naturally the smaller the opening at the lower end of the tube and the larger the opening in the side of the tube, the more completely will the fluid be broken up and mixed with air as it is drawn from the vessel. It can be seen that a very fine calibration of the two openings must be arrived at when the principle is applied to a carburetor. The air-bleed must not be too large nor too small, neither must the calibrated opening at the end of the tube be out of proportion.

The arrangement just described, when incorporated into a carburetor jet, usually takes the form similar to that shown in Fig. 48. This type of jet will give a uniform mixture under steady speed throughout its range of operation. It has been learned that when a mixture is desired which is slightly richer at low speed than at high speed, it may be obtained by making the air-bleed large or by confining the upper portion of the jet passage. This principle is made use of when a Stromberg carburetor is fitted to an engine, that is, the size of the main passage or main discharge jet is calibrated with extreme care to fit the characteristics of the engine being equipped.

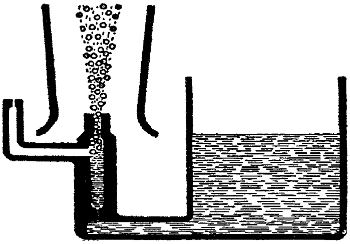


Fig. 48. Air-Bled Jet with Single Venturi

Venturi Tubes. When a carburetor with a fixed size air opening is fitted to an engine, if the air opening is large enough to give the engine full power at high speeds, then the suction at the jet tends to be very low at low speeds. The use of a venturi-tube-shaped air opening gives the carburetor air capacity at high speeds while at the same time it gives higher velocity and increased suction at low speeds.

The Stromberg engineers make use of this principle as illustrated in Fig. 48 with a still further improvement in this direction, obtained by the use of a double or combined venturi tube, as shown. The air-bleed arrangement in connection with the double venturi ordinarily takes somewhat the form illustrated in cross section in Fig. 49.

Idling System. It is practically impossible to get a satisfactory idling speed if the main jet is depended on to supply all of the fuel. This is because of the fact that when the throttle is closed, as shown in Fig. 50, the suction below the throttle is relatively slight. On the other hand when the throttle is closed, as shown in Fig. 50, the suction above the throttle is at its highest. For this reason, the arrangement shown of providing a separate passage for the fuel to a point just above the closed throttle is made use of. As shown in Fig. 50, the idling passage draws the fuel from the main jet so that no fuel can come through the idling system that has not already been metered through the main-jet system. At very low speeds the mixture is controlled by the idling orifices or openings. At higher speeds the mixture is controlled by the high speed orifices although a considerable amount of fuel may be going through the idling passage. Whether the fuel may be going through the idling passage or not depends upon where the suction is highest—at the idling passage or at the idling discharge jet. If the suction is highest at the small venturi, the fuel will spray from the main discharge jet; and if it is highest at the idling jet, more fuel will be drawn from

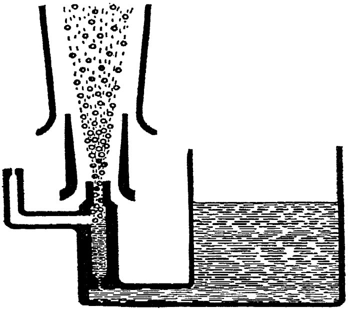


Fig. 49. Air-Bled Jet with Double Venturi

that point. Naturally, the greater the suction the more complete the atomization of the fuel drawn from the jet.

Gasoline Economizer. The air-bleed jet can be set to give a uniform mixture proportion at normal speeds and loads. By using large size air-bleed openings, it is also possible to obtain a graduation such that the mixture at speeds above 30 miles per hour will be quite a bit leaner than at lower speeds. Experiments have shown that with most engines a still further variation of mixture is necessary to give smooth operation throughout the entire range of speeds.

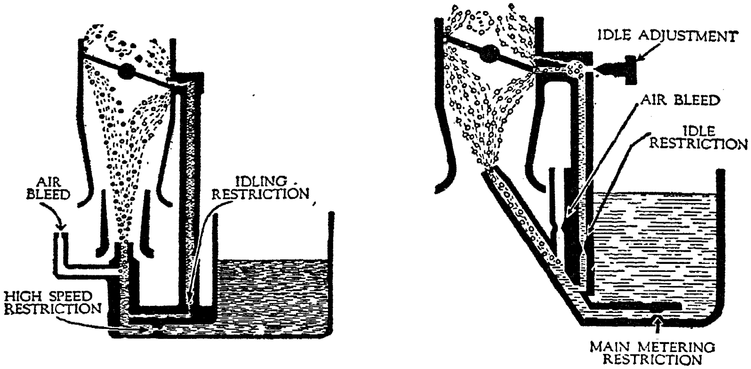


Fig. 50. Left —Model "O" Carburetor
Right—Model "U" Carburetor

The Model "O" idling jet is a single hole just above the closed butterfly throttle. The Model "U" form makes use of one small hole just above the closed throttle and another one which is partially closed by the throttle valve at closed position.

If the fuel consumption is measured when the carburetor is in operation, with different carburetor adjustments, it very likely will be found that the lowest fuel consumption is obtained with a mixture so lean that, with any throttle position or any driving speed, the car speed will pick up a little when the mixture is made richer. In other words, the mixture which gives best economy is too lean for best power. With drivers educated to expect considerable snap and power from their cars, it is necessary to design the carburetor to make use of a little more gasoline under a pull or at high speed in order to get the full power of the motor. These same drivers when loafing along, with the throttle only partially open, are desirous of having the best possible gasoline economy and so the carburetor is designed to give a leaner mixture for these loafing speeds.

Economizer Action. Since 1914, the Stromberg carburetors have been provided with a fuel economizer. This economizer action is designed to graduate the mixture so that with any given gasoline adjustment the mixture will be somewhat richer at the larger openings of the throttle than at the partially closed throttle positions generally used in driving.

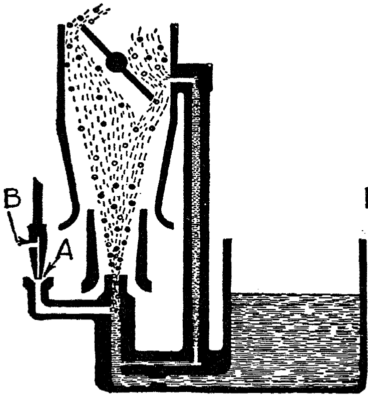


Fig. 51. Nearly Closed Throttle
The idle jet is in use and also the largest air bleed.

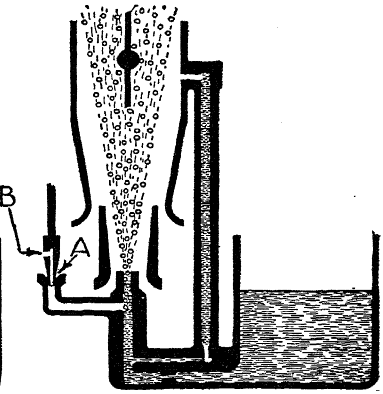


Fig. 52. Wide-Open Throttle
The idle jet is out of use and the air bleed is partially closed.

In certain models of the Stromberg carburetors, the economizer action is obtained by varying the size of the air-bleed opening as shown in Figs. 51 and 52. From idle up to about one-third of the throttle opening (which really gives more than half the air capacity of the carburetor), the economizer needle is raised from its seat, as shown at *A* in Fig. 51. This allows a relatively large amount of air to enter the fuel jet to break up the fuel and emulsify it. As the throttle is opened, the economizer needle will seat, as shown at *A* in Fig. 52. This results in reducing the size of the air-bleed opening to that of a very small hole (drilled through the needle point plug in the vertical carburetors). In the case of the horizontal models, it is reduced to the size given by the external bleeder plug. This arrangement will give a leaner mixture with the throttle closed and the needle raised, as shown in Fig. 51, than it will with the throttle fully open and the needle A closed, as shown in Fig. 52.

High-Speed Air Bleed. The air-bleed opening when the economizer needle is seated is known as the high-speed or compensating bleed and its size is selected according to the richness of the mixture desired at wide open throttle throughout the range of car speeds; but when determining this size, the car should be taken to a hill which will hold it down to a low speed, preferably not over 15 miles per hour, and the proper gasoline needle seating obtained. The car should then be tried for full speed and a high-speed bleeder size used that will give the best mixture at maximum speed with the same gasoline needle setting which gives best power on the hill.

Economizer Reducer. The amount of economizer action is controlled by the amount of air which is admitted to the jet when the economizer needle is raised and this may be regulated by the economizer reducer. See Fig. 55 for an arrangement of this. In finding this size, the gasoline adjustment is set to give the best power on a hill that will hold the car down to a speed of 20 to 25 miles per hour. The size should then be selected to give a mixture which is so lean at part throttle opening that the gasoline needle adjustment—as found on the hill—cannot be cut down one notch without causing the motor to fall away in speed for a given partial throttle opening. In all cases the size of the economizer reducer should not exceed the size of the main discharge jet opening.

On the Model "U" Stromberg carburetors, the desired enrichment at half- to full-open throttle position is obtained by means of a gasoline valve, Fig. 55. With this type, the main metering jet size is selected for best economy at closed throttle; the economizer by-pass jet is then selected of such size as will give full power and the best operation at full-open throttle. On some of the models, the economizer needle valve is opened mechanically by the action of the same arm that operates the acceleration pump, as shown at A in Fig. 55. On certain other models, the economizer needle valve is operated according to the intake manifold vacuum, which in turn depends upon the engine load. At idle and light loads, the vacuum economizer piston is sucked up against a spring. When the throttle is opened or a heavier load placed on the engine, the manifold vacuum drops and the spring pushes the piston down to open the economizer needle valve, as shown at *B*. The fixed air-bleed opening is known as high-speed or compensating bleed, and its size is selected according to richness of mixture desired at wide-open throttle.

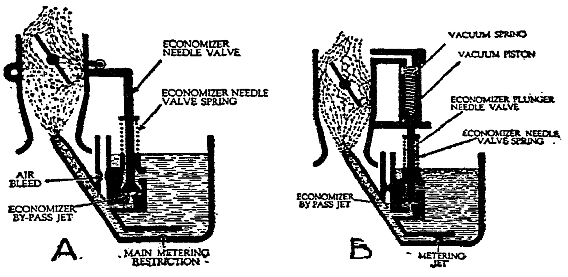


Fig. 55. Gasoline Valve Economizer
A—Mechanical-Operated Form
B—Vacuum-Operated Form

Model "U." This type operates on the plain-tube principle and constructional features as developed by the Stromberg engineers. A special form of accelerating pump is perhaps the chief feature of difference in Model "U" over Model "O." In smaller sizes of this series a single venturi tube is used and an inclined main discharge jet is usually fitted with fixed size metering jets, also called cup jets, and it also incorporates a gasoline economizer.

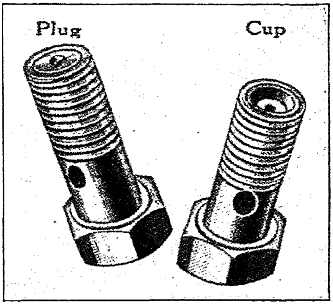


Fig. 56. Main Metering Jets Used in the Stromberg Model "U" Carburetor

The lower idle discharge hole is almost entirely below the throttle valve when the valve is entirely closed. The air-bleeder size is taken as constant and the required adjustment of mixture range is obtained by varying the size of the main discharge-jet bore. Three types of high-speed fuel regulation are employed in these carburetors. A high-speed metering jet generally used has a sharp-edged thin-plate metering orifice formed as a small cup pressed in its tip. These jets are usually used on six-cylinder engines and are called cup jets, Fig. 56. Another form of metering jet, which is used on the four-cylinder engines and for twin carburetors, as would be the case with eight-cylinder engines, contains a plug or bushing in its end. It has a longer metering orifice with beveled ends and is called a plug jet.

These two types of jets have different characteristics and must not be confused. The jets are marked according to their orifice diameter in thousandths of an inch and have all been tested to see that their fuel delivery is up to standard. Make very certain that the two types of jets are not confused when servicing carburetors. The plug jet delivers much more fuel than the cup jet and has a characteristic of giving a richer mixture in proportion at high suctions.

Economizer Action. In the Model "U" carburetors, economizer action is secured by a submerged gasoline valve, operated by vacuum from the pump arm as the throttle is opened wide. See Fig. 55. Its fuel delivery or amount of economizer action is determined by the economizer restriction or by-pass jet, which has a "cup" form of metering orifice pressed in its tip. In setting these carburetors, the high-speed metering jet or needle setting is selected to give most economical smooth running in the part throttle range. If this mixture ratio is then found to be too lean at wide-open throttle and full load, a by-pass jet is put in of the size necessary to give the added enrichment.

Accelerating Pump. The chief characteristic of these later carburetors is the Stromberg design of accelerating pump, which possesses the advantage of giving a positive and definite accelerating charge regardless of the suction which may exist in the manifold and carburetor. This charge is delivered as a momentary spurt of fuel, followed by a sustained discharge of fuel lasting several seconds. The first spurt of fuel is rather geyser-like in action. The sustained flow of fuel is somewhat less but continues over an appreciable time. The amount of this charge is automatically reduced as the temperature within the engine compartment is increased.

The accelerating device in its several stages of operation is illustrated in Fig. 57. It consists of a cylinder with its upper end closed. This cylinder is forced downward by a lever as the throttle is opened. Within the cylinder is a piston, which slides on a vertical stud. When the throttle is in fixed position, the piston is seated against the conical end of the stud, as shown at *A*. This closes the gasoline passage to the main discharge jet. When the throttle is opened and the pump cylinder suddenly depressed, the piston is forced down by the gasoline trapped above it and a quick spurt of fuel is delivered through the stud opening to the main discharge jet, as shown at *B*. As the throttle is held in this position, the piston slowly rises under the force of its spring. This is the action which delivers a further accelerating charge at a gradual rate into the main discharge jet. In certain of the Model "U" carburetors the amount of normal accelerating fuel charge is governed by the size of the hole in the head of the stud, while in certain other models a gasoline reducer plug is threaded into the passage between the stud and main discharge jet. The size of these jets varies between No. 56 and No. 68 drill size and the delivery of the pump is measured as the number of cubic centimeters of gasoline that will drain into the air horn when the carburetor is set up vertical on a stand under normal fuel head and the throttle opened ten times in succession. The flow required with different engines at different seasons varies from 3 cubic centimeters in ten strokes of the pump to 30 cubic centimeters. Naturally in warm weather when the temperature becomes high under the hood and the temperature of the carburetor likewise is high, gasoline vapor is liberated from the body of fuel within the float chamber. The cylinder space of the pump becomes partially filled with this vapor, thereby automatically reducing the amount of the accelerating charge.

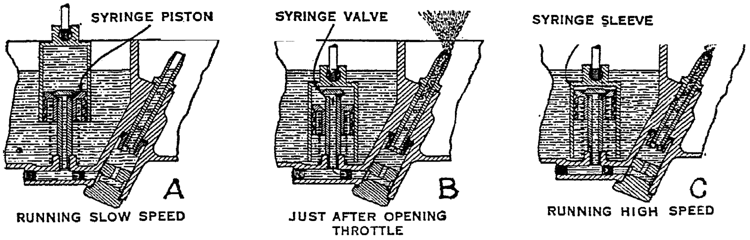


Fig. 57. Action of Stromberg Accelerating Pump

When determining the proper pump setting, the hole in the top of the stud or the reducer in the pump passage should be increased as necessary to improve the response to the throttle with engine fairly cool. The action of the carburetor should then be tested with the engine warm, at a temperature of 140 degrees Fahrenheit or more under the hood, to make sure that the response of the engine does not become sluggish from too much gasoline when the throttle is opened from idle.

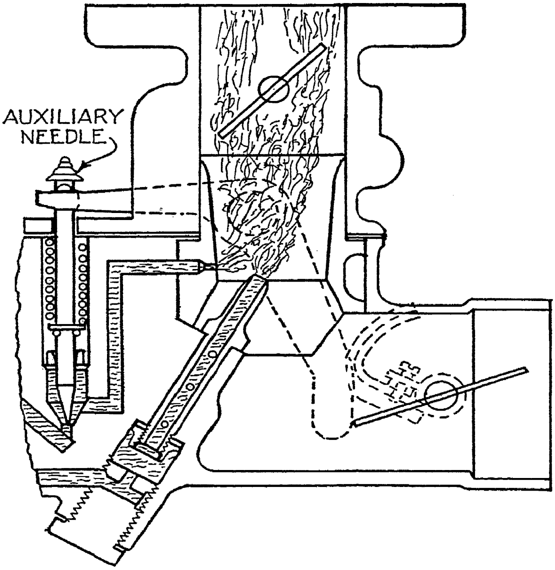


Fig. 58. Auxiliary Needle in Stromberg Carburetor
When the choker is pulled out, the choker valve cam strikes the lower end of a bell crank which raises an auxiliary needle and opens a gasoline passage to the venturi as an aid in starting.

Starting and Warming Up. Have the engine well warmed up so that the intake pipe above the carburetor is at least warm to the hand, then slow the engine down until minimum steady idling speed is reached. Then turn the low-speed adjustment very slowly to the right or left until the steadiest running and fastest running for that throttle position is obtained. This adjustment operates on air so that screwing it in gives a richer mixture and screwing it out gives a leaner one. If after this adjustment is made the engine idles too fast, turn the throttle stop screw counterclockwise to reduce the minimum throttle opening until the desired idling speed is reached. If the engine idles too slow, as would be indicated by its rolling sound and easy stalling, then screw the throttle stop screw inward or clockwise to increase the minimum idling speed. With the engine idling properly, there will be a steady hiss in the carburetor. In case this hiss is not even, the auxiliary control needle, Fig. 58, may not be seated. In order to secure proper idling speed on present-day fuel, the gap between the spark-plug points must not be less than .022 inch nor more than .028 inch if wide-open throttle operation will permit.

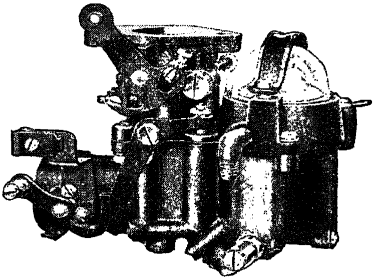


Fig. 59. Exterior View of the Stromberg Model "U" Carburetor Fitted with Vis-a-Gas Feature

With the instructions which are given in order that the car driver may secure proper operation from his carburetor when starting, include the following suggestions:

When the engine is warm, simply throw on the switch, step on the starter and at the same moment depress the accelerator pedal slightly. In moderately cold weather the throttle lever on the steering wheel is opened slightly until the accelerator button can be felt to move downward. Pull out the choke button on the dash from $\frac{1}{8}$ inch to $\frac{3}{8}$ inch, turn on the ignition switch, and depress the starter button until the engine starts. In cold weather the throttle should be opened the same amount or a little more, the switch should be put on and the starter button simultaneously depressed, and at the same time the control should be pulled out all the way and held there from one to five seconds. As the engine begins to fire, return the control gradually, opening the throttle a little further in case the engine is very cold. Owing to the choke valve and auxiliary needle connection, shown in Fig. 58, the engine will be flooded if it is cranked with the dash control pulled all the way out for ten to fifteen seconds. If flooding results, allow some time for the accumulated gasoline to drain out and try cranking with wide-open throttle.

Float Level Adjustment. The gasoline level in the float chamber should be set with the float level $\frac{9}{16}$ inch below the gasket face of the float chamber except in the case of the Model "UX-4," where the distance is $1\frac{9}{32}$ inch. In other words, the gasoline level with the engine idle should be $\frac{9}{16}$ inch below the top of the float bowl. If the float is low, bend the arm so as to move the float upward toward the float-chamber cover the same distance as the level needs correction—that is, to raise the level $\frac{1}{16}$ inch, bend the float up $\frac{1}{16}$ inch; to lower the level, hold the float arm tight where it touches the needle and bend the float downward away from the float-chamber cover.

Stromberg Vis-a-Gas. A number of the Stromberg carburetors, notably the Model "U," are fitted with the Stromberg vis-a-gas. This little device has a transparent cover which goes over the carburetor bowl and contains within it a gasoline strainer. Every drop of gasoline entering the carburetor is strained of dirt and impurities, thus preventing the clogging of the small orifices and jets in the carburetor. This device may easily be drained or cleaned. It is shown in position on the Model "U" in Fig. 59.

STROMBERG DUAL OR TWIN CARBURETORS

Model "OO." The Model "OO" carburetor is made in the $1\frac{1}{4}$ inch size only and is used on certain eight-cylinder cars. It has a single high-speed needle adjustment, which regulates a fuel orifice in series with two metering jets, each of which feeds one barrel of the main discharge jet. The idling adjustments, which are individual for each barrel, are different from other models in that they employ needles regulating the upper idle discharge hole at all times, which is above the throttle valve and thereby regulates the mixture from the minimum idling speed up to about ten miles per hour. The mixture from 10 to 18 miles per hour is regulated by the size of the fuel and air-bleeder orifices in the idling tubes. This construction allows a very close adjustment on the idles, as has been found necessary with dual carburetors. A single accelerating well is used with individual outlets to the small venturi in each barrel. The accelerating well is usually fitted with the thermostat control.

Model "OO" is illustrated in Fig. 60. The instructions as given for the adjustment of dual carburetors, Model "UU," are also applicable to this carburetor.

Model "UU." The Model "UU" has the same float mechanism, venturi tubes, main discharge jets, and idle systems as the Model "OO" but carries the accelerating pump and economizer similar to the Model "U" series. A needle adjustment is supplied to control the pump action, its setting ranging from one-half turn open in the summer to three turns open in the winter. Plug type metering jets of the Model "U" series are employed. These are shown in Fig. 56.

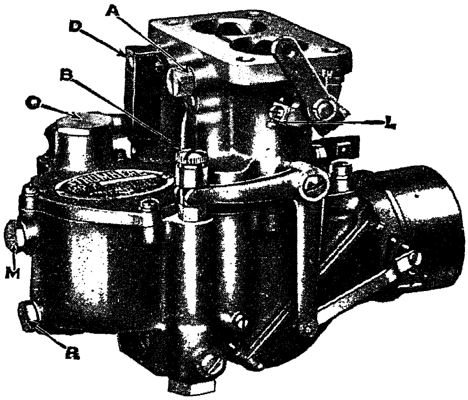


Fig. 60. Stromberg Twin-Type Carburetor-Model "OO-2"

Idling Adjustment. With the dual carburetor the idling adjustment is somewhat sensitive, due to the fact that the throttle cracks only about .003 inch wide when the engine is idling. This is approximately half that needed with a single carburetor of the same capacity. These idle adjustments regulate the fuel so that screwing them out gives a richer mixture and screwing them in gives a leaner mixture.

With the engine at a normal operating temperature, retard the spark halfway and screw the inner idle adjusting needle (the one toward the engine) all the way into its seat. This cuts off the gasoline supplied to the four cylinders fed by the manifold branch above the inner carburetor barrel and will cause the engine to slow down considerably. Both of the idle adjustment screws are marked *A* in Fig. 61. This action cuts off the gasoline to the four center cylinders, that is, cylinders 3-4-5-6 which are fed by the inner carburetor barrel.

Next proceed to adjust the outer idle adjustment needle so the four outside cylinders 1-2-7-8 will fire smoothly. Allow the needle to remain in this position.

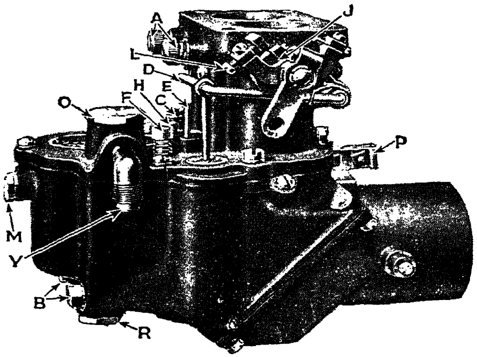


Fig. 61. Stromberg Twin or Dual-Barrel Carburetor-Model "UU-2"

Next open or unscrew the inner idle adjustment until all eight cylinders begin to fire and the position for smoothest operation for cylinders 3-4-5-6 has been found. Allow the needle to rest at this point.

Recheck the outer needle *A*, cutting it down slightly when the adjustment has been found for this needle. Allow it to remain. Preferably the adjustment should be slightly rich for each of the two needles.

If after the idle speed adjustments have been made the engine runs too fast, turn the throttle stop screw *L* counterclockwise to reduce the minimum throttle opening until the desired idle speed is reached. If the engine idles too slow, as would be shown by the rolling sound or stalling action, the throttle screw should be screwed inward or clockwise to increase the minimum idling speed.

When the engine is idling properly, there should be a steady hiss in the carburetor. If the hiss is unsteady, the auxiliary control needle *C* may not be seating.

The suggestions for starting and warming up as given for the Model "U" carburetor apply with reference to this carburetor.

Float Level Adjustment. The gasoline level in the float chamber should stand, with the engine idle, even with the bottom of the level sight hole *M*, Figs. 60 and 61. As the engine is raced to high speed, the level will naturally fall. If the carburetor floods continuously, remove the strainer plug *O*, clean the strainer, then replace and flush out the float chamber by turning on gasoline full with drain plug *R* removed. If flooding continues after this, take off the top of the float chamber and float mechanism with it and inspect the needle valve point and needle valve seat. Tapping the needle valve into the seat with a screwdriver handle, while rotating it in several positions, will sometimes give good results. In case the needle valve point shows wear, it should be replaced.

If, after the above treatment, the fuel level, when sighted through the opening *M*, stands above or below the bottom of the level sight hole, readjustment may be made by bending the lever arm in the corner between where it touches the float needle and where it meets the float body. The factory setting for the float of these carburetors is $\frac{7}{32}$ inch from the top of the float to the bottom face of the float chamber cover, when the float needle is seated.

STROMBERG DOWN-DRAFT CARBURETOR

Model "D." One of the latest developments in the carburetor field is the application of the down-draft principle. The proper application of the idea secures a more complete distribution of the fuel. The Stromberg down-draft carburetors incorporate the well-known and long-used plain-tube principles. All of the theory as given herein covering the Stromberg models has application in and understanding of the operation of the Model "D," illustrated in Fig. 62. The Model "D" incorporates the following principles:

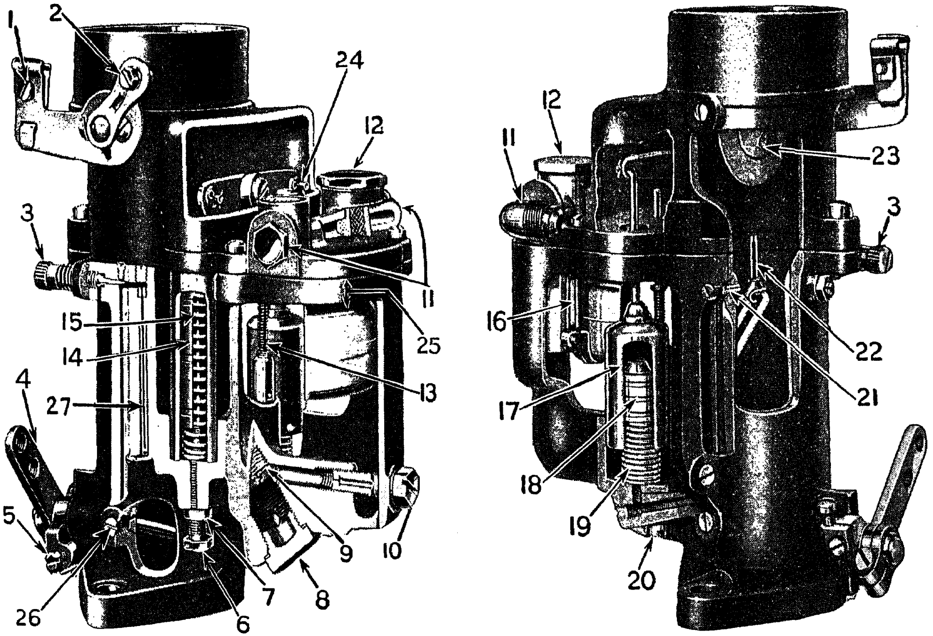


Fig. 62. Sectional Views of the Stromberg Type of Downdraft Carburetor

1.—Choke Control Tube Holder. 2.—Choke Lever Wire Clamp Screw. 3.—Idling Needle Valve. 4.—Throttle Lever. 5.—Throttle Stop Set Screw. 6.—Pump Adjustment Screw. 7.—Vacuum Piston Stop Screw Lock Nut. 8.—Main Discharge Plug. 9.—Main Discharge Jet Retainer Plug. 10.—Main Metering Jet. 11.—Gasoline Connection. 12.—Strainer Plug. 13.—Economizer Needle Valve. 14.—Vacuum Piston. 15.—Vacuum Piston Spring. 16.—Float Needle Valve and Seat. 17.—Pump Piston Sleeve. 18.—Pump Piston. 19.—Pump Piston Spring. 20.—By-Pass Metering Jet (Economizer). 21.—Pump Discharge Nozzle 22.—High-Speed Air Bleeder. 23.—Choke Valve (Flapper Type). 24.—Pump Piston Link. 25.—Float Setting. 26.—Idle Discharge Plug. 27.—Idle Tube.

1. A semi-automatic choking device for starting.
2. A positive acting accelerating device, consisting of a syringe pump which delivers an accelerating charge immediately the throttle is moved and meters and delivers this charge over a definite period of time.
3. An adjustment to vary the quantity of accelerating charge, according to climatic conditions.
4. Idle and low-speed jets below the throttle, with separate idle adjustments for smooth low-speed performance.
5. An economizer which permits the carburetor to operate on a very lean and economical mixture and which automatically shifts to the needed richer setting when the full power of the engine is called for.

Starting and Warming Up. The usual procedure for starting in cold weather is to open the throttle about one-third the way. Next throw on the ignition switch and pull the choker out all the way. Then step on the starter button. Hold the choker out all the way until the engine starts, then open the choker by pushing in the control slowly, while at the same time the throttle may be closed slightly, thus having the engine operating at a fairly fast speed. Continue to adjust the choker until the engine runs smoothly and allow the engine to warm up slightly before attempting to operate the car. When the dash control is all the way out, it is essential that the choke valve in the carburetor entrance be closed completely. If trouble is experienced in starting, inspect the connection and note whether this condition is secured.

NOTE: When the engine is warm and it is desired to start it immediately, open the throttle to about a thirty-mile per hour position, turn on the ignition switch, and step on the starter. If a start is not made immediately, pull the choker control out for an instant and immediately push the choker control in again to normal position. This will prevent flooding the hot engine.

Float-Level Adjustment. When the engine is not running, the proper gasoline level is $\frac{7}{8}$ inch below the top of the float bowl. The proper setting for the Model "D," shown at *25* in Fig. 62, is $\frac{23}{64}$ inch from the lower surface or gasket face of the cover to the top of the float at its center. Bend the float lever arm in the corner to correct the setting, bending it an amount equal to the correction desired.

Low-Speed Adjustment. If the carburetor adjustment has been tampered with or destroyed for any reason, the first thing to do is to have the engine well warmed up so that the intake pipe above the carburetor is approximately 120 degrees, which will be quite warm to the hand. Slow down the engine by means of the throttle lever on the steering wheel until the steady minimum idling speed is reached. Turn the low speed adjustment *3* in Fig. 62 right and left until the steadiest running and fastest running for that throttle position is obtained. Turning this adjustment in gives a richer mixture and turning it out gives a leaner mixture. Secure the best operation for the throttle opening and if this should be too fast for idling, it will then be necessary to adjust the small throttle stop screw *5* by turning it counterclockwise to reduce the minimum throttle opening. In case the engine would be too slow, as would be indicated by its rolling and stalling easily, then the screw should be turned inward until the proper idling speed is secured. If this does not give a proper idling speed, remove plug *26* and see that the two holes near the lip of the throttle valve are open and clean. Also remove idle tube *27* and see that the small hole in the end is open and that air can be blown through the tube. Use extreme care in handling these parts so as not to enlarge any of the orifices and thus destroy the calibration.

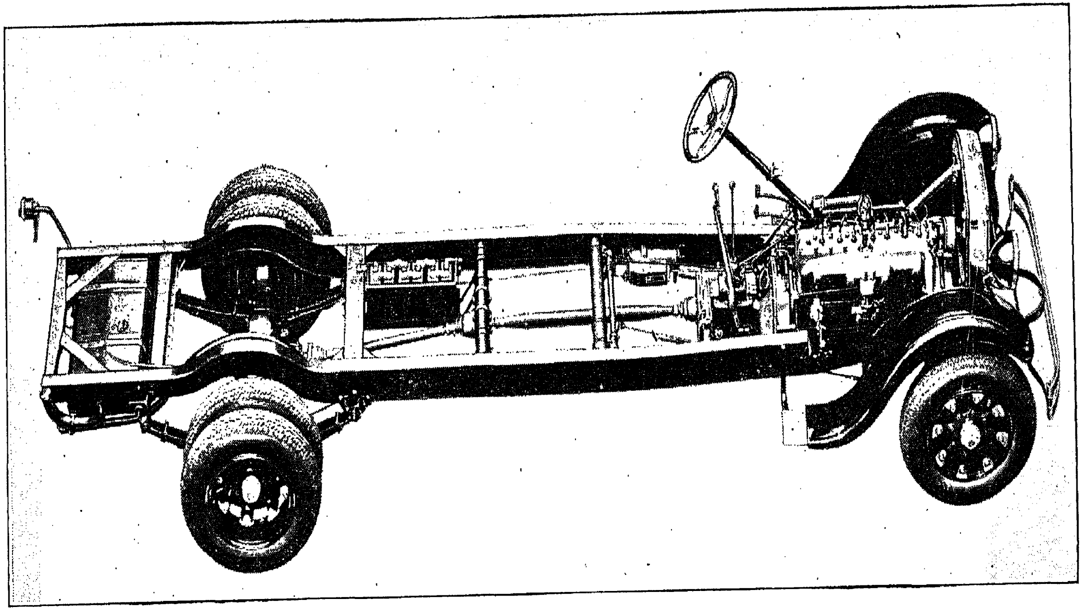
Intermediate Speed. The fuel mixture at intermediate speed is controlled by the size of the main metering orifice *10* in Fig. 62. The size of this orifice is stamped on the outer face of the jets in decimal parts of an inch. It is not likely that this size will need to be changed except in cases of damage, when parts should be replaced. On wide open throttle, an additional quantity of fuel is supplied by the by-pass metering jet *20*.

Accelerating-Pump Adjustment. The pump adjustment screw *6*, Fig. 62, controls the quantity of fuel which is delivered by the accelerating pump. The normal factory settings do not ordinarily need to be changed. In hot weather the accelerating pump discharge may be reduced by turning the screw up or to the right and in winter the quantity may be increased by turning the screw to the left or down. Loosen lock nut *7* before adjusting and tighten it after making the adjustment.

Lincoln-Zephyr Carburetors. This carburetor is of the dual down-draft type, made by Stromberg, with an accelerating pump which allows rapid acceleration. The carburetor also has an auxiliary valve choke. All orifices are of the fixed type, excepting the idling jets which are controlled by the idling adjusting screws. The idling speed of the engine is controlled by the throttle stop screw, and should be so adjusted that the engine speed is equal to a car speed of five miles per hour.

To make the idling adjustment, the engine should be thoroughly warmed up, and there should be no air leaks at the intake manifold to cylinder connections or at the windshield wiper, or distributor vacuum connection. The idling adjustment screws are found below the float chamber. The idling adjustment controls the proportion of gasoline-air mixture being fed to the engine for low speed operation. For a richer mixture the screws are turned out, while turning them in gives a leaner mixture. One side of the carburetor should be adjusted at a time. Turn the idling adjustment screw slowly inward until the engine begins to run irregularly or starts to lag, then turn the screw slowly out until the engine tends to roll with the rich mixture, then slowly turn the screws inward just enough to make the engine run smoothly. The other side should be adjusted in like manner. After this adjustment is made, it may be necessary to correct the idling speed of the engine to the five-mile an hour setting by the throttle stop screw.

Oldsmobile Carter Carburetors. On the recent Carter carburetors as fitted to the Oldsmobile cars, a device called an anti-percolator has been fitted. This device prevents fuel being forced through the main jets into the intake manifold by the heat of the motor after hard or fast driving, which causes the fuel to boil and makes the fuel flow through the main nozzle into the manifold. This excess gasoline in the manifold is the cause of hard starting with a hot motor. If hard starting is experienced under the foregoing conditions, the anti-percolator adjustment should be carefully checked. To check this adjustment, set the throttle valve with .020 inch between the throttle valve edge and the throttle bore on the side opposite the port. The lift on the pump arm on the six cylinder, and the metering arm on the eight cylinder, should be adjusted to allow .005-inch to .015-inch clearance between the valve stem and the lip. As there are two anti-percolator devices on the L-36 carburetors, they must be adjusted equally. In doing this, the setting of the metering rods must not be changed. Carefully check the setting of the anti-percolating units after the metering rods are installed.



STUDEBAKER EIGHT-CYLINDERS-IN-LINE BUS CHASSIS

CARBURETORS

PART II

FORD CARBURETOR

Model "A." The Ford Model "A" carburetor is of the plain-tube type. There are two adjustments to the carburetor, one being provided for slow-speed adjustment and the other for high-speed adjustment. In addition to this there is a provision for choking, this provision being in combination with the high-speed nozzle adjustment.

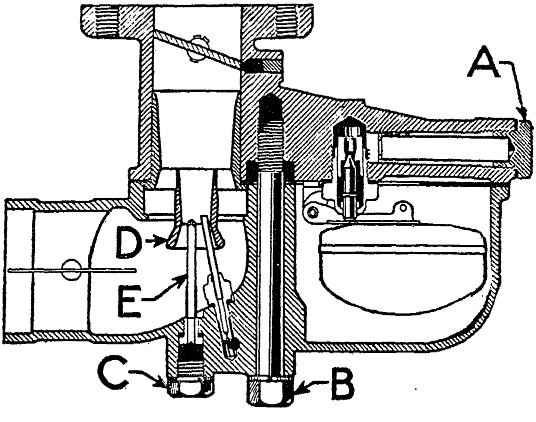


Fig. 65. Sectional View of Ford Model "A" Car Carburetor

Referring to Fig. 65, it will be noted that gasoline enters at the point *A*, flows through a screen, and drops into the float chamber. As the float rises on the gasoline, the level is automatically controlled. The air choke for starting is embodied in the carburetor in the air passage. The main gasoline jet *E* is located in the venturi *D*. It will be seen that if the butterfly valve in the air intake is turned across the air passage, that a very considerable suction is induced around the main gasoline jet *E*.

As in most plain-tube carburetors, it will be noted that there is a primary and also a secondary venturi. The larger venturi is the primary and is located just under the throttle valve.

Cleaning Carburetor. If the carburetor performance is not all that is expected, the filter plug *A* should be removed and the screen lifted out. Any dirt may then be blown out with the air line and the passage rinsed out with gasoline. If this does not cure the trouble, it will be necessary to disassemble the carburetor. In order to do this, remove the main assembly bolt *B*, Fig. 65, and carefully separate the parts to avoid damage to the gasket, float, and idling jet tube. Next remove the plug *C* below the main jet *E* and use air to blow out dirt and rinse with gasoline to remove any dirt in the bowl or jets. Use extreme care to see that all parts are reassembled in proper position.

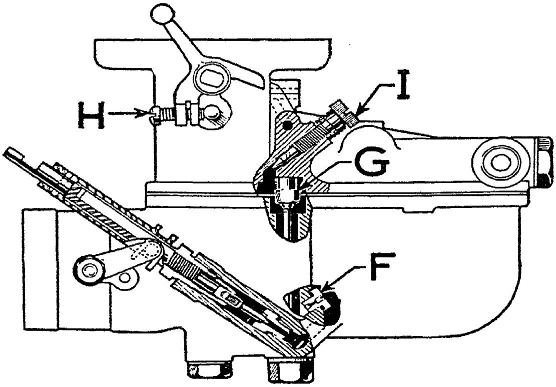


Fig. 66. Adjustments on Ford Model "A" Car Carburetor

Testing Carburetor. It is a generally recognized fact that it is impossible to adjust the carburetor on a new engine until such time as the engine has been run in. The gasoline consumption will be higher for a time for this reason.

When adjusting the carburetor for economical performance, it is imperative to have the engine warm. In many instances it is necessary to adjust the carburetor for driving conditions where it is seldom that the engine is thoroughly warmed up. This would be the case in city driving for short distances with many stops.

Idle Adjustment. The ignition of the engine should be in first-class condition and the ignition timing should be properly set. The first step in adjusting the carburetor is to retard the spark fully. Next adjust the throttle adjusting screw *H*, Fig. 66, until the engine will turn over at a fair rate and not stall. Then turn the idle adjusting screw *I* in or out until the engine operates smoothly and shows no signs of stopping or galloping. After this adjustment has been made, the next step is to reset the throttle *H* until the engine idles at the desired speed. This speed is usually found when the idling screw *I* has been turned two or three turns off of its seat

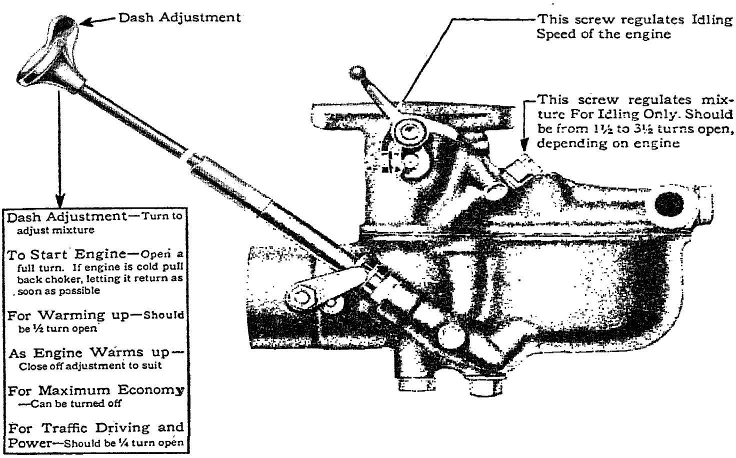

Dash Adjustment
This screw regulates Idling Speed of the engine
This screw regulates mixture For Idling Only. Should be from 1½ to 3½ turns open, depending on engine
Dash Adjustment—Turn to adjust mixture
To Start Engine—Open a full turn. If engine is cold pull back choker, letting it return as soon as possible
For Warming up—Should be ½ turn open
As Engine Warms up—Close off adjustment to suit
For Maximum Economy—Can be turned off
For Traffic Driving and Power—Should be ¼ turn open

Fig. 67. Chart of Adjustments on Ford Model "A" Car Carburetor

Dash Adjustment. The dash adjustment, Fig. 67, is a choke and screw adjustment. The choke is spring returned so that after the engine is started, the butterfly in the air passage in the carburetor is in wide-open position. The screw feature of the dash adjustment is so designed that it may be turned several turns from its seat in order to keep a cold engine running without bucking. As soon as the engine starts to warm up, the adjusting screw should be turned in toward its seat. This operation is gradually continued until the needle valve seats completely. The device is so designed that seating the needle valve does not completely stop the flow of gasoline through the main jet. In many cases it is possible to operate the car with the needle valve seated completely. If the power obtained from the engine is not all that is desired, the needle valve may be backed off about one-quarter to one-half turn. Naturally, the grade of gasoline being used has considerable to do with the amount of opening required, some grades requiring an opening of one-half turn more than other grades.

This feature is a very desirable one when driving in high altitudes, since it is possible to seat the high-speed needle completely, thus giving a leaner mixture. Contrary to popular opinion it is not good gasoline economy to turn the carburetor so low that the engine will barely turn over or develop the power needed. Tests on the road have shown conclusively that the adjustment at which the engine develops the best power is the most economical. These tests have shown that with a mixture as lean as it is possible to have the engine operate on, less miles per gallon were secured than with a proper mixture.

Trouble-Shooting Hints. Check the gasoline tank to see whether the fuel supply has been exhausted. Next, check the feed line to see that fuel flows to the carburetor freely. Finally, make certain that there is fuel in the carburetor. If no fuel feeds to the carburetor, remove the plug and screen *A*, Fig. 65, and clean them. The next thing is to check the secondary venturi *D* to see that it is in the position shown. If the car owner complains of lack of speed, the main jet *E* should be checked to see whether it is clean and free of any particles of dirt which may have tended to clog it. If the customer complains of poor idling and poor slow-speed performance, the compensator *F*, Fig. 66, should be checked to see that it is clean. The idling jet *G* furnishes all of the gasoline for idling, consequently the tube and metering hole must be kept clean and free of dirt. If the customer complains of leaks about the carburetor, the parts should be checked for physical damage and all connections should be tightened.

Surprising as it may seem, there are many owners who are fearful of touching the dash adjustment on their cars. These are the customers who are likely to complain about the lack of fuel economy. As a matter of fact, they are running with the screw adjustment turned back from its seat as much as a turn or more. The best plan is to take these customers on the road and show them how simple a matter it is to adjust the carburetor and then have them adjust the carburetor until they are thoroughly familiar with it. The characteristic sounds of a properly operating engine, or one which is too rich or one which is too lean, are easily learned by any one if the proper instruction is given.

FORD "V-8" TYPE CARBURETOR

Early Models*

The Ford "V-8" carburetor is of the down-draft type, specially adapted for the Ford "V-8" engine, Fig. 68. The carburetor size is $1\frac{1}{4}$ inches. The carburetor is entirely automatic, and as the adjustments are made at the factory, it is claimed they will remain correctly set unless tampered with.

The two main units are the main metering unit and the auxiliary unit. The main metering unit is composed of a pair of air valves, so arranged that they open downward to admit air in the mixing chamber. On these valves are fingers which actuate a centrally located aspirating tube. As the valves are lowered, they open the aspirating tube. This aspirating tube is attached to a spring loaded hollow stem, with the fuel metering orifice at its upper end, and into this orifice an adjustable tapered metering pin projects.

The auxiliary unit combines a passage for starting, an acceleration pump, and an auxiliary power jet. The lining up of progressively located ports in the starting sleeve with passages in main body controls the operation of the auxiliary unit. The movement of the choke valve rotates the starting sleeve; and as the throttle is opened, the pump plunger and piston move downward.

The correct ratio of air and gas is maintained by the action of the air valves and the metering device. At idling speed the valves are closed, and the metering pin almost closes the orifices in the air valve piston. As the suction increases, it draws the air valve down and the metering pin is also lowered, and this causes the enlargement of the metering orifice and thereby allows more gas to pass into the air stream, giving a correct mixture.

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*The later type Ford "V-8" Double-Barreled Carburetors are described later in this section.—Ed.

For maximum power at any car speed, a richer mixture is obtained by way of a power jet, which supplies extra fuel as long as the throttle is held open. The lower air bleed holes, located in the starting sleeve, control the amount of gasoline drawn through the power jet.

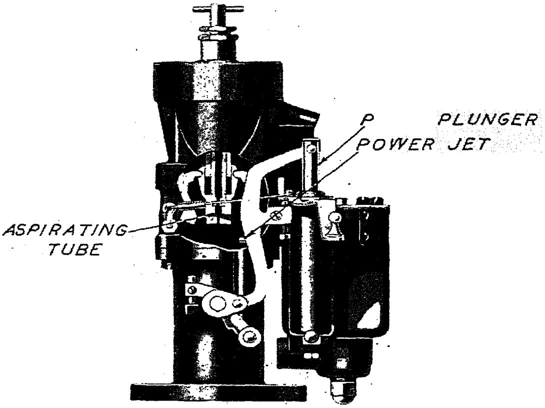

Fig. 68. Ford "V-8" Single-Barrel Carburetor

For quick pick up, a rapid opening of the throttle causes a rapid downward movement of the pump plunger and piston, which in turn forces gasoline up through the hollow stem of the pump plunger into the mixing chamber.

To prevent the gasoline leaving the pump cylinder and returning to the float bowl, a check valve is placed at the bottom.

Generally only one adjustment is required and that for idling speed. When the metering pin is set correctly, the carburetor is also set for maximum engine operation.

With the engine thoroughly warmed up, turn the metering pin adjustment down until the engine operation indicates a lean mixture, and then open metering adjustment until engine operates smoothly.

Be sure that there are no air leaks in the intake system, or in any attachment operated by the intake vacuum.

MARVEL CARBURETORS

The Marvel carburetor is quite similar in all of its models, irrespective of whether the heat control is applied to the device or not. When the heat control device is applied, the outward form of the carburetor is considerably changed. However, the inner construction and the principles involved in the operation of the carburetor remain very similar. The influence of the heat control will be discussed with reference to the different models.

The distinctive feature of the Marvel air valve is a tongue-like or flapper-like arrangement which is carefully manufactured to fit in the lower part of the air passage just above the high-speed or medium high-speed nozzles, where two of these are used.

Marvel Heat Control. This device is a distinct Marvel design. The principles involved may be explained in a few words. It is exactly the same as though a few drops of liquid were poured on to a hot stove lid. Instant vaporization occurs.

Principles of Marvel Up=Draft Carburetor. This is shown in Fig. 69 and other figures. Three jets are provided within the mixing chamber. These jets provide the required amount of gasoline for the varying speeds. The low-speed jet is located in the venturi, which is a fixed air passage. The high-speed jet is located just under the air valve and an intermediate high-speed jet is just under and back of the high-speed jet. The gasoline jets are of a fixed size, calibrated at the factory to meet the requirements of the engine to which the carburetor is fitted. The air valve, which is located at the lower end, is in the nature of a tongue, carefully designed to fit into the circular form of the carburetor body.

The only adjustment of this carburetor is that of the air-adjusting screw which controls the air-valve spring tension. Earlier models were provided with a gasoline adjusting screw for the low or idle-speed jet. Improvements in later designs do away with having an adjusting needle at this point.

Choker. The choker valve is unique in design in that the lower side of it is weighted. In Fig. 70 the butterfly choker valve with a weight attached to its lower edge is shown in full view in a position which would correspond to approximately 15 miles per hour car speed. A phantom or dotted line view shows the same butterfly choker valve further opened—a position which would correspond to 30 miles per hour car speed. As the car speed increases and the demand for air increases, the butterfly throttle choker valve is pulled farther and farther open.

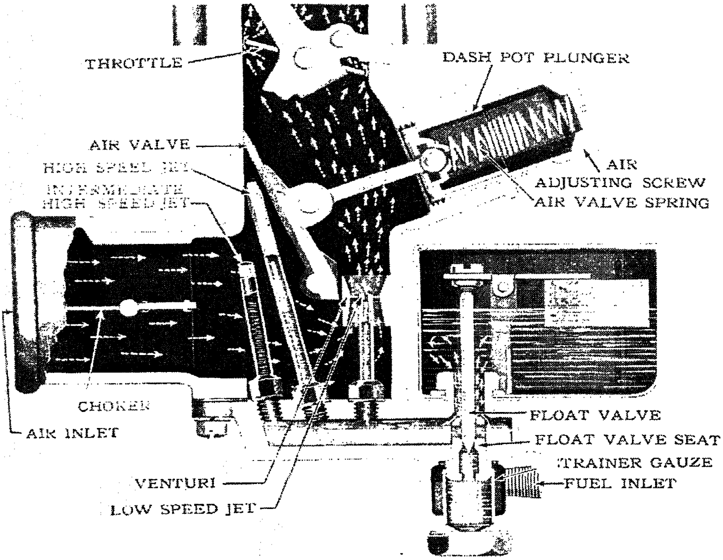

Fig. 69. Parts of a Typical Marvel Carburetor with Idling Action Illustrated

When starting the engine, the choker may be closed by means of the choker control on the dash. The choker is first pulled all the way out and then the throttle is opened about one-quarter, after which the starter button is depressed. When the engine fires, depress the choker part way. If the engine hesitates, pull the choker a bit farther out and then proceed to push it in as rapidly as the engine warms up.

Adjusting the Carburetor. First make certain that the heat control valve on the exhaust manifold is set in a proper position for the season of the year or the climate in which the car is being operated. The next point to inspect is the top of the carburetor fuel bowl where a little lever will be found. See Figs. 73 and 74. This should be set for summer or winter markings, depending upon the season.

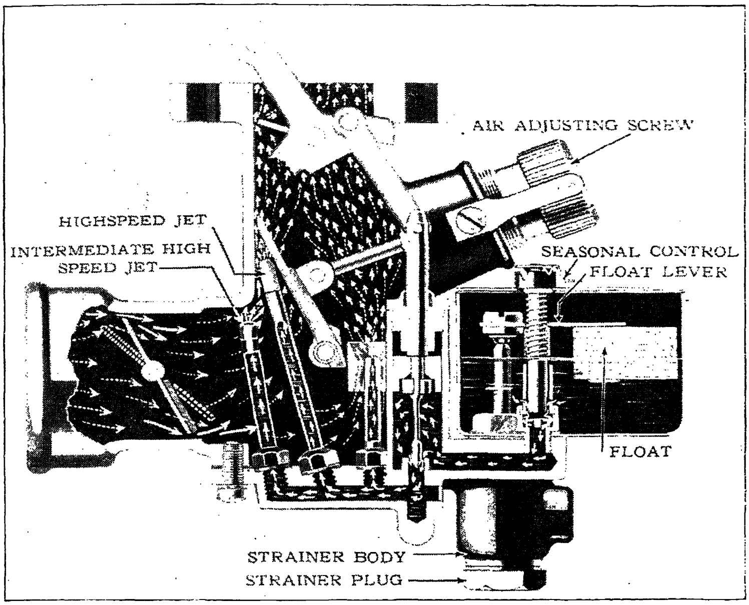

Fig. 70. Automatic Action of Choker Valve Illustrated

Next make certain that the gasoline or fuel passages are clear to the carburetor and that the carburetor screen is not clogged. Check the fuel pump to see that it is supplying a proper amount of fuel; also check the manifold and other connections to see that there are no air leaks. Start the engine and run it until it is thoroughly warm. Check the ignition system to see that it is in good condition. It is useless to attempt to adjust a carburetor to compênsate for deficiencies of other systems.

Set the air-adjusting screw of the carburetor so that the end of it is flush with the end of the ratchet spring. Now turn the air-adjusting screw inward a few turns until the engine starts to roll, after which it may be turned out a few notches until the engine falters through leanness. Midway between these two points will be found the proper setting. This is the only adjustment to be made in order to secure proper carburetor performance for all engine speeds and loads. The engine speed at which to proceed with adjusting of the air screw is that approximating 10 miles per hour on the road, then reduce speed to desired idling speed for final check.

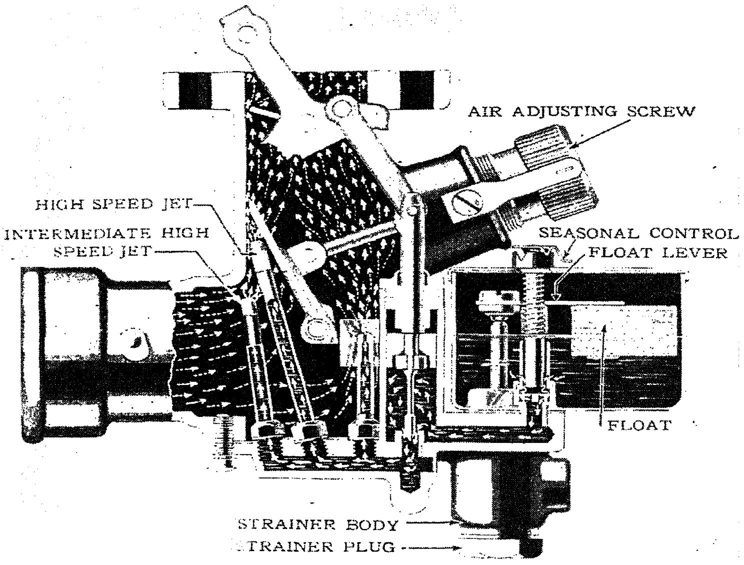

Fig. 71. The Economizer Action—Fuel and Air Are Represented by Arrows

Adjusting Idle Screw. It is necessary to check the car on the road in order to prove the setting of the idle adjusting screw which controls the opening of the butterfly throttle valve. This should be set so that the car operates at a speed of at least 5 miles per hour.

Carburetor Operation. The passage of the fuel from the bowl direct to the low speed jet in the venturi is shown in Fig. 69. The adjustment of the air valve to pass more or less air effects the flow through the fixed air passage. The air entering the carburetor comes in past the choker. The carburetor suction on low speed is induced by more pressure on the air-adjusting screw. In this way more or less fuel is caused to flow from the low-speed jet and consequently the low-speed adjustment is secured by means of the air-adjusting screw.

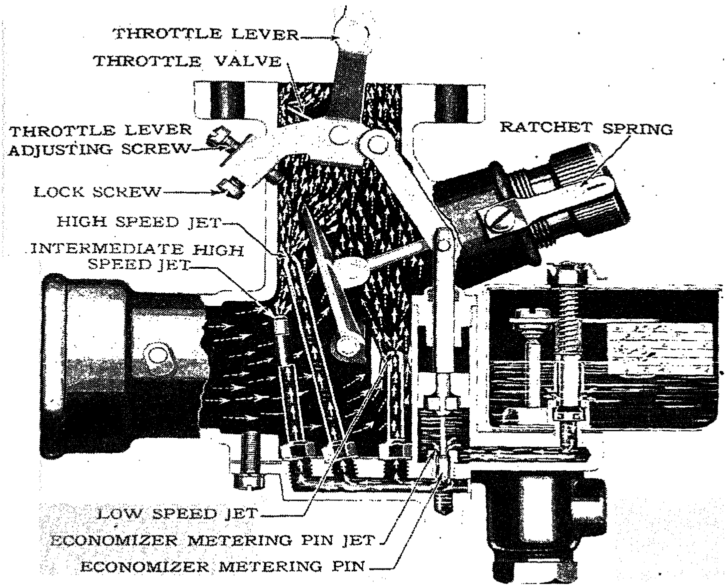

Fig. 72. Economizer Action from 50 Miles per Hour to Wide-Open Throttle

Economizer Action. The economizer action is illustrated in Figs. 71 and 72. The economizer metering pin is attached to the throttle control. See Fig. 68. It will be noticed that the lower end of the economizer pin is provided with an enlarged point. This point being in the economizer metering-pin jet provides a calibrated opening through which the gasoline flowing to any of the jets must pass. As long as the enlarged portion of the metering pin is within the jet, this holds. This condition obtains for all speeds of the car up to approximately 50 miles per hour. After passing this speed, the throttle being wide open, the metering-pin enlargement is dropped below the calibrated opening with the result that an additional flow of gasoline is permitted. This is illustrated in Figs. 73 and 74.

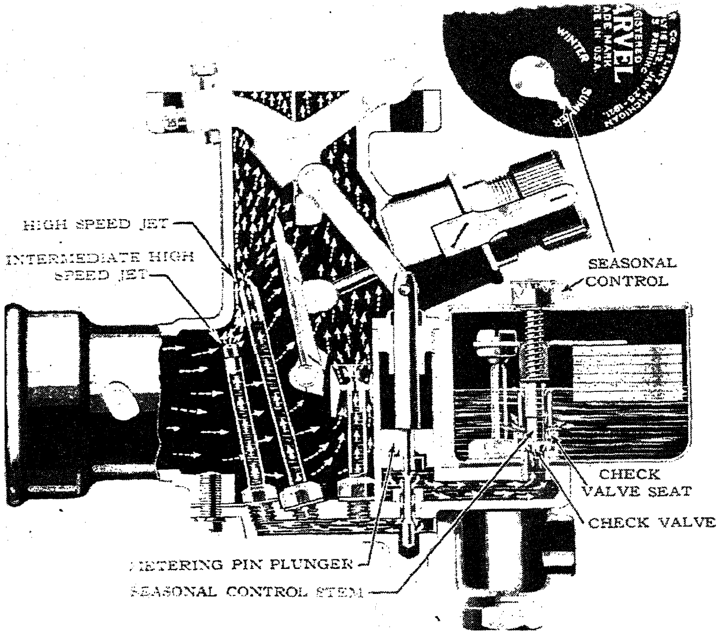

Fig. 73. Winter Setting for Accelerating Device

When the metering pin has dropped below the metering-pin jet, the amount of gasoline is no longer measured by this jet but is measured by the calibrated opening of the high-speed and intermediate high-speed jets. These are so calibrated as to provide for a proper mixture of air and gasoline for fullest power and best acceleration as would be secured when traveling over the level at high speeds or up hills or hard going. On the accelerating device there are two settings, for winter and summer. The action of the carburetor when accelerating rapidly with the winter setting is illustrated in Fig. 73. The arrows going into and through the gasoline and air passages indicate the action of the mixture. It will be noted that the air valve is open wide. It will also be noted that the plunger connected to the throttle lever has moved down and forced the check valve under the seasonal control stem up against its seat so that all gasoline within the passage from the check valve over to and in the accelerating well must be forced ahead of the descending metering-pin plunger and out through the calibrated openings of the high-speed jets. This fuel, of course, is picked up and acts as the required accelerating fuel to mix with the large amount of air entering past the air valve. The seasonal control on the top of

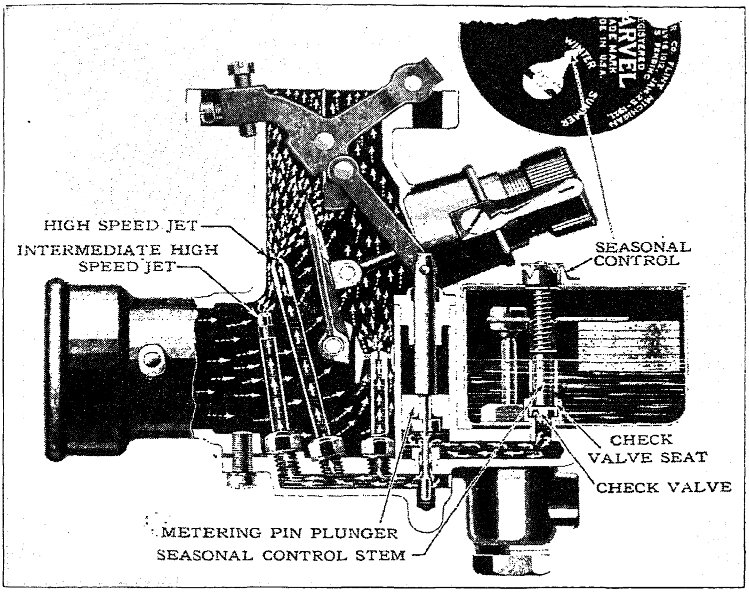

Fig. 74. Summer Setting for Accelerating Device
The insert in the upper right-hand corner shows the dash controls.

the carburetor bowl in the setting shown is up and away from the check valve so that it can raise against its seat.

With the summer setting which is shown in Fig. 74, the stem of the seasonal control is down on the check valve for summer driving. This prevents the valve from closing. The result is that when the throttle is opened wide for rapid acceleration, the metering pin plunger cannot force all the fuel in one direction, part of it going back into the bowl and a little of it being forced from the high-speed jets. This feature of design, if properly set, results in economy of fuel in the summer months while at the same time the desired acceleration may be secured for driving in colder climates.

Float-Valve Setting. The setting for the float valve is $\frac{11}{32}$ inch from the top edge of the float bowl to the top of the cork float. **The seasonal control should always be set** to "winter" in cold weather and the manifold heat should always be set "hot" for cold weather driving. If the performance of the car is sluggish in the summer months first check the seasonal control and see that it is set to "summer" position. After this, if the performance still remains poor and sluggish, the manifold heat control should be set to "cold" position.

BUICK UP-DRAFT MARVEL CARBURETOR

The Marvel automatic air valve, multiple jet type carburetor is used on Series "50-60" and "90" models. This carburetor employs a single float bowl with twin mixing chambers, air valves, throttles, and heat risers. The throttles are carried in the heat riser between the carburetor body and intake manifold. Four non-adjustable jets are provided in each mixing chamber as follows: The low-speed nozzle is within the venturi. The high-speed and intermediate high-speed jets are just under the automatic air valve and controlled by it, and a submerged-economy jet is in the sump and under the high-speed standpipe.

A single adjustment is provided, which is the air adjustment screw that regulates the tension of the air-valve spring. A plunger within this screw provides resistance, in addition to that of the air valve spring, to aid in acceleration. The float valve is an overhead type which prevents fuel being drained from the bowl when the car is parked with the front end higher than the rear.

The low-speed nozzles and intermediate high-speed standpipes have extensions on their lower ends reaching very close to the bottom of the bowl sump. The bowl is so designed that the economy jets are also located to take fuel from the bottom of the bowl sump. This design thus prevents vapor bubbles from passing through all nozzles and jets. See Fig. 75. For full power requirements, fuel is metered through the low-speed nozzles, high-speed, and intermediate high-speed jets. For part throttle driving range, economy jets are placed between the main fuel supply and the high-speed jets.

The additional fuel required for full power requirements, or wide open throttle operation is supplied by a non-adjustable fuel by-pass valve automatically operated by the carburetor throttle. This fuel is by-passed through a very short channel to the high-speed standpipes, Fig. 76, entering just above the economy jets. At part throttle driving range, this valve is automatically closed, so that the calibrated nozzles and jets control the amount of fuel being used. When the throttle is fully opened for high speeds, hard pulling, or quick acceleration, this valve opens and supplies additional fuel necessary to obtain the maximum power from the engine.

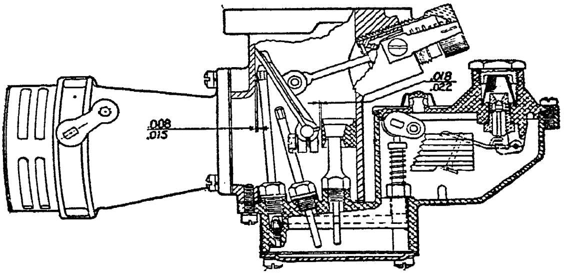

Fig. 75. Buick Carburetor in Cutaway View

Adjustment. No change should be made in the carburetor adjustment until after inspection has been made to determine if the trouble is in some other unit. It should be determined that the gasoline lines are clear, that the fuel pump is properly supplying fuel, that there are no leaks at connections between the carburetor and engine, that the ignition system is in proper condition and that there is even compression in all cylinders.

If it is necessary to test adjustment or to make a readjustment, proceed as follows: Turn the air screw so that the end is flush with the end of the ratchet spring bearing against it. With the engine warmed up, adjust the air screw for proper idling. Turn the air screw to the left until the engine hesitates, indicating that the mixture is too lean. Next turn the air screw to the right three or four notches at a time until the engine runs smoothly. Open the throttle a small amount and immediately allow it to snap back to the closed position. If the engine stalls, the air screw should be turned to the right. If it rolls, the air screw should be turned to the left until the engine continues to idle smoothly. This brings the carburetor into complete adjustment for the entire range of engine speeds and loads. Except for altitude territory, service abroad, and certain foreign fuels, no change from standard jets should ever be made, as no better power, speed or fuel economy will result thereby.

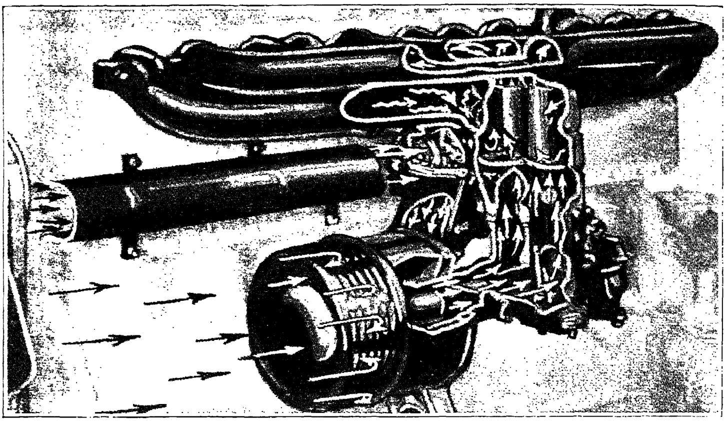

Fig. 76. Buick Carburetor and Heat Control

Adjusting a carburetor, so as to secure just the last bit of fine performance from the engine, is an operation which requires knowledge of the principles of design of the carburetor being adjusted. After that is gained, experience is the best teacher.

If the engine idles too fast with the throttle closed, the latter may be adjusted by means of the throttle lever adjusting screw.

No change is necessary for touring through mountainous country, but for cars operating permanently in territory of 3000 feet elevation or higher, it is advisable to change the carburetor calibration to obtain best performance.

Cold Idle Control. The cold idle control, Fig. 77, consists of a thermostatically operated cam *K* mounted on the carburetor heat riser. This cam serves as the stop for the idle adjusting screw *D*. The function of the cold idle control is to provide a fast idle speed during the warming up period of the engine. This speed increases or decreases as the temperature of the riser changes. The variable speed is obtained by using a thermostat *A* which drives the cam *K*. When the riser is cold the thermostat *A* rotates the cam *K* in a clockwise direction, causing its thick side to contact with the idle screw *D*, which speeds up the engine. As the riser warms up, the thermostat is heated and thus revolves the cam *K* in a counter-clockwise direction until the idle screw *D* is contacting with the cam *K*, at its thinnest section, causing the carburetor throttle to close to a normal hot idle speed.

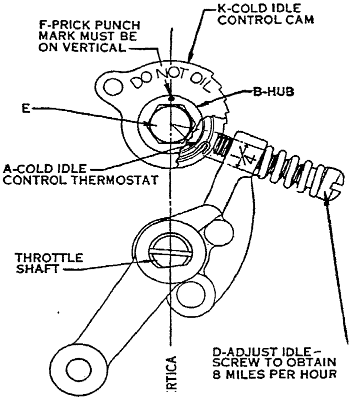
K-COLD IDLE CONTROL CAM
F-PRICK PUNCH MARK MUST BE ON VERTICAL
DO NOT OIL
B-HUB
E
A-COLD IDLE CONTROL THERMOSTAT
THROTTLE SHAFT
RTICA
D-ADJUST IDLE-SCREW TO OBTAIN 8 MILES PER HOUR

Fig. 77. Cold Idle Control

The cold idle control is adjusted and set in the correct position at the factory and with ordinary care should not need any further adjustment. This setting can be checked as follows: Loosen nut *E* and rotate cam hub *B* in the direction necessary to place the prick punch mark *F* directly above nut *E*. This adjustment may be made regardless of heat riser temperature. A momentary opening of the throttle is necessary to allow the cam *K* to adjust itself for any temperature position. This is because the spring *A* is not capable of rotating cam *K* while the idle adjusting screw is contacting the cam.

Warm up the engine. The idle adjusting screw *D* should now contact the cam *K* on its thin portion and within the $\frac{1}{4}$-inch limit adjoining the first raised section of the cam. See Fig. 77. If the idle adjusting screw does not contact within the limit shown, the cam hub may be rotated slightly in order to bring $\frac{1}{4}$-inch section under the idle screw. If it is necessary to rotate the hub enough to move the center punch mark *F* more than 5 degrees away from its normal top position, a complete new cam assembly should be installed. All moving parts of the cam assembly should operate freely and no oil should ever be used on them.

Buick Carburetor Automatic Choke. The Delco-Remy automatic choke is attached to the front side of the carburetor riser. It takes the place of the conventional hand choke of the engine under all weather and temperature conditions. It gives immediate performance and is fully automatic.

The operation of the Delco-Remy automatic choke is controlled by the variation of the three fundamentals in present carburetion systems, namely: 1. Hot spot or carburetor riser temperatures; 2. Manifold vacuum; and 3. Carburetor air inlet velocities. The thermostatic spiral spring in the automatic choke has one end secured to the shaft, which controls an offset choker fly in the carburetor air horn by means of linkage. The other end of the thermostatic spring is connected to a spring loaded bellows.

This thermostatic spring has the property to increase its tension, by further winding itself up, as the temperature decreases and vice versa. Due to this characteristic, when the engine cools down, the thermostatic spring increases the tension on the choker fly and chokes the carburetor in proportion to temperatures. When starting a cold engine, the choker fly should be held closed with the correct tension until enough fuel has been lifted in the intake system to produce initial firing of the engine. As soon as the engine fires, the vacuum in the manifold rises rapidly and vaporizes a certain amount of fuel, which calls for a leaner mixture. The force of this vacuum is used to collapse the spring loaded bellows. This rotates the thermostatic spring end in a clockwise direction and decreases the initial tension on the choker fly of the carburetor.

The amount of decrease in tension is regulated by the stroke variation of the bellows. This variation is obtained by an adjustable (cam shaped) stop, which gives the correct tension for proper choker fly position under all part throttle engine loads and speeds. The spring tension will regulate itself according to temperature, and decrease as the engine warms up until the automatic choke is completely out of operation. The time required for the choker fly to travel from the choking position into the part throttle position is controlled by a metering pin, which regulates or meters the vacuum action on the bellows.

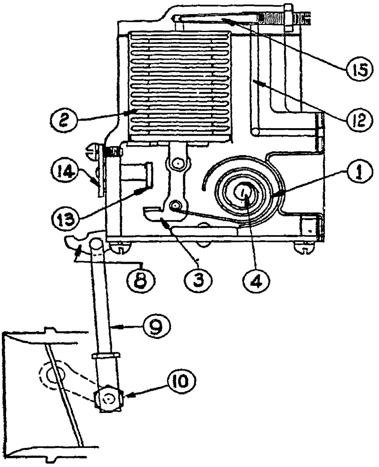

Fig. 78. Buick-Delco-Remy Automatic Choke

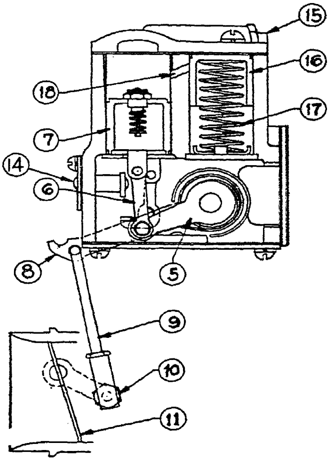

Fig. 79. Another Sectioned View of the Buick Choke

Service and Adjustment. The Delco-Remy automatic choke parts and service are available through United Motors Service branches and their authorized stations. This choke unit should not be disassembled except by the above named organization. The units are properly calibrated at the factory, and it should not be necessary to make any adjustments in the field. However, if trouble arises, the following procedure is recommended.

First remove the link *9*, Figs. 78, 79, and 80, from automatic choke lever *8*. Hold down both levers *8* and *10* as far as they will go. Check the length of link *9*. Adjust to fit into the notch of the automatic choke lever *8*. Reinstall link *9* in lever *8*. Next check the choker fly action by moving the automatic choke lever *8* up and down. Moving parts must work freely and the lever must always come back to its original position. (Original position, meaning position in which levers are found, due to choke temperature at the time of checking.) Make sure all moving parts and joints are dry and free from oil of any kind. Never oil any part of the choke mechanism.

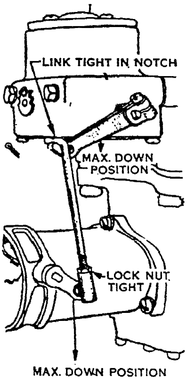

Fig. 80
Link Adjustment

Engine Does Not Start. If the engine fails to start after several trials, with the choker fly in the full choke position, probably the engine is flooded. If flooded, open the choker fly by hand, by pulling up on lever *8*. The engine can probably then be started and run sufficient to eliminate flooded condition.

Stop the engine and let it cool down until the choker fly is again in full choke position. Start the engine again and notice if the choke lever travels slowly up to its part throttle position. If not, the vacuum is failing to release the choke, therefore, check for vacuum leaks, vacuum channels plugged, or incorrect bellows metering-pin timing.

Bellows Metering-Pin Timing. The bellows are properly timed at the factory and before making new adjustments, make certain that all vacuum leaks and channel obstructions are eliminated. If timing is necessary, proceed as follows: Allow the engine to cool until the choker fly returns to closed position. Start the engine and check the time required for the automatic choke lever to travel up to part throttle or upper position. It should take 12 to 15 seconds to complete this movement. Time can be increased or decreased by adjusting the bellows metering pin *15* in or out.

Caution. See that the metering pin lock nut is securely tightened after adjustment.

Idling. Idling speeds must be correct for proper engine starts in summer as well as in winter. Idle should be set for 7 to 8 miles per hour in high gear with warm engine. (See Cold Idle Control.)

Part Throttle. The part throttle setting of the choke is indicated by adjusting the disc *14*. This is set at the factory in the center notch between rich and lean and should not be changed.

Acceleration. With the engine running and the automatic choke lever *8* in the upper or off position, accelerate the engine suddenly. The lever *8* should drop immediately and momentarily, then return to its original position. The intensity of this action should decrease until it practically ceases to function as the engine becomes hot.

Cold Weather Starting. In cold weather, the clutch should be disengaged by depressing the clutch pedal before depressing the accelerator pedal to remove the drag caused by cold oil in the transmission and insure a higher cranking speed. Turn on the ignition switch. Depress the clutch pedal (in cold weather). Depress the accelerator pedal.

When the engine first fires, keep the foot on the accelerator pedal long enough to make sure that the engine will keep running. As a further assistance in cold weather starting, it may be desirable to use a good grade of high-test gasoline. In districts where the climate provides lengthy periods of sub-zero weather, it may be advisable to remove the heat valve thermostat shutter, by disconnecting the shutter operating link at the throttle lever and removing the retaining washer and spring. This will leave only the open thermostat cover which will allow cold air to blow on the thermostat at all times, maintaining a high tension on the heat valve, thereby giving a higher mixture temperature. With the return of warm weather, the shutter and parts should be reinstalled, as a cold thermostat will give mixture temperatures too high for normal weather, resulting in loss of performance.

Heat Control. The carburetor and manifolds have been designed to utilize the exhaust gases of the engine to insure complete vaporization and a consequent minimum consumption of fuel. A double-walled twin riser, Fig. 81, is placed between the carburetor and the intake manifold, connecting to the exhaust manifold on one side and held in place by four studs. The gases, passing to the riser jacket through the upper opening and returning through the lower opening to the exhaust manifold, are automatically controlled by a thermostatically operated damper valve located in the exhaust manifold outlet.

The damper valve applies the greatest amount of heat to the riser, when in a closed or horizontal position, Fig. 81, decreasing the amount as it moves to the open or vertical position. The damper valve fly is offset, or longer on one side of the valve shaft than the other, which allows the exhaust gas pressure to force open the valve when free to move. The valve is so arranged that at no time is all the heat shut off from the riser. A sufficient amount of heat is allowed to pass into the riser to insure proper vaporization of the fuel.

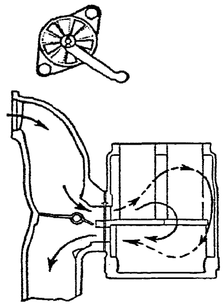

Fig. 81. Heat On
Damper Closed
Shutter Closed

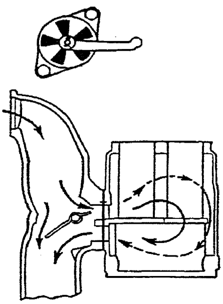

Fig. 82. Medium
Damper Partially Closed
Shutter Open

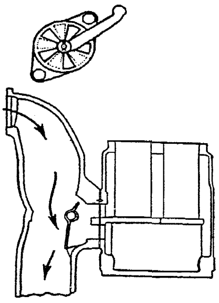

Fig. 82A. Heat Off
Damper Open
Shutter Closed

The thermostat controlling the damper valve consists of a bimetal strip wound so as to form a coil around the damper valve shaft, with the inner end inserted in a slot in the end of the damper valve shaft. The outer end of the coil is hooked around an anchor stud on the damper valve cover.

The setting of the thermostat, Fig. 82, should be approximately one-half turn windup at normal room temperature, causing tension to be applied to the damper valve, holding it in a horizontal or "heat on" position and forcing exhaust gases through the riser. Heat conducted by the damper valve shaft to the thermostat causes it to unwind, reducing the tension on the damper valve which allows the valve to be forced, by the exhaust gas pressure, toward the vertical or "open" position shown in Fig. 82A.

As more temperature is required at part throttle to insure best performance and economy, it is necessary to cool the thermostat and cause it to wind up. This tends to close the damper valve, and applies more heat to the riser. This is accomplished by a cover, which completely encases the thermostat, having a shutter operated by the throttle lever through a link, which at intermediate car speed or part throttle, is opened in proportion to the throttle movement from approximately 30 to 70 miles per hour. Air from the fan, directed by an air tunnel fastened to the engine, passes through the opening of the shutter and cools the thermostat, which automatically increases the mixture temperature.

For open throttle running and hill climbing, the shutter is held closed, which keeps the heat around the thermostat and causes it to unwind. This allows the damper valve to open, and reduces the mixture temperature.

Marvel Manual Heat Control. The carburetor and manifolds have been designed to utilize the exhaust gases of the engine to insure complete vaporization and a consequent minimum consumption of fuel. This is accomplished by an exhaust jacket in a double-walled riser casting, placed between the carburetor and intake manifold. This riser casting is also connected with the exhaust manifold in such a manner that the exhaust gases pass through a small jacketed section of the intake manifold, entering an opening at the top and back of the riser, passing down between the jacket walls of the riser, and then out to the main exhaust. The amount of heat thus furnished to the riser is controlled by a damper valve in the main exhaust.

This damper valve in the main exhaust is connected to the throttle lever of the carburetor by connecting a rod in such a manner that the greatest amount of heat is had in the jackets of the riser when the throttle is only partly opened, as in idling and at low speeds, and a decreasing amount as the throttle is opened farther for higher speeds. By means of a season adjusting stud on the heat-control lever on the damper-valve shaft, this automatic action of the heat valve may be varied to suit weather and driving conditions.

The damper valve is in the main exhaust at the rear end of the engine and is assembled in the exhaust-manifold casting. On the front side of this damper-valve cover will be noticed a boss, acting as a locating stop for the damper-valve lever. This stop indicates the closed position of the damper valve and is to be used in assembling the connecting rod to the carburetor. The normal position of the damper valve is against this stop when the season adjusting stud on the heat-control lever is set at "hot" and the throttle is in closed position.

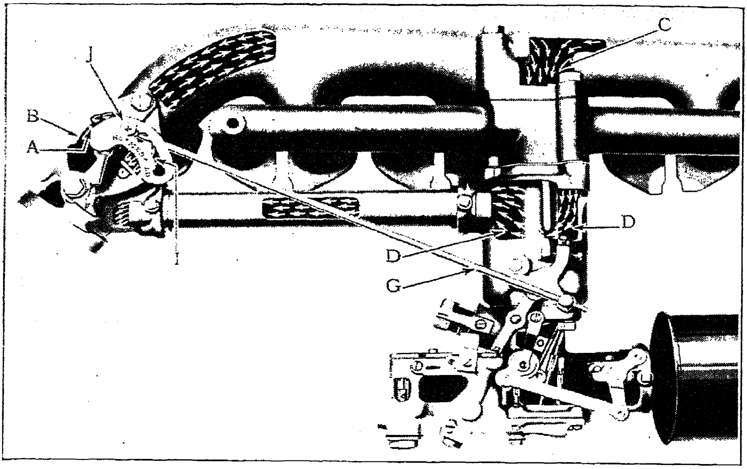

Fig. 83. Marvel Control in "Hot" Position
The valve *A* is closed to deflect heat through the riser.

An adjustment for seasonal control of heat is provided on the damper-valve lever *I*, Fig. 83, whereby the amount of exhaust heat deflected by the damper to the riser jackets may be decreased by moving the damper adjusting stud *J* from the hook-up hole in the damper lever marked "hot" to the hook-up hole marked "medium" or to the hook-up hole marked "cold," thus initially opening the damper valve at closed throttle positions and greatly reducing the heat application.

Gases from the main exhaust pass through a small jacket on the intake manifold and enter at an opening at the top and back of the riser, Fig. 83, and then pass down through the riser jackets, returning to the exhaust pipe below the valve *A*. It will be noted that valve *A* is connected by means of connecting rod *G* to the throttle stop lever. As the throttle is opened, valve *A* is also opened, due to this interconnection. Thus the volume of heat through the heat jackets of the riser will be lessened as the engine speed increases, depending upon the position of the season adjusting stud *J* in the damper lever *F*.

In Fig. 83, showing "hot" heat position, note the shape of the exhaust manifold land *B*, adjacent to the edge of the valve in closed position. At closed throttle, valve *A* is at the extreme right-side edge of the land *B* in the exhaust manifold. As the throttle is opened, valve *A* rotates counterclockwise so that its edge passes across this land *B* but the valve itself does not open until it clears the land *B*, thus insuring maximum heat circulation.

Servicing Model "T"* Marvel Carburetor. This carburetor is equipped with a heat control which varies with different devices furnished for different makes of cars the principles upon which they operate being quite similar. When servicing the carburetor, make a careful inspection of the heat-control device. Note whether the main damper valve in the exhaust is properly hooked up so that, when the throttle is closed against it and the heat control is set with all the heat on, the main damper valve comes to full-closed position.

Preliminary Adjustment. First set the spark retarded and then adjust the idle speed by turning the air screw *A*, Fig. 86. Screw this out until the engine falters, then turn it in the opposite direction a few notches at a time until the engine runs smoothly. Have the engine thoroughly warmed up when making this adjustment. Also make sure that the heat control lever on the instrument board is set in a medium position for summer and with all heat on in the winter. If the air screw is turned in too far, a rolling effect will be noted in the engine and this indicates too rich a mixture. Adjust the air screw *A* until an even operation of the engine is secured.

Idle Adjustment. This is made by adjusting the throttle-adjusting screw *B*. First loosen the lock screw which holds *B* in the lever and then turn the adjusting screw to what would seem to be the approximate engine speed for about 5 to 6 miles per hour. Test the car on a level stretch of road to see whether an even operation is secured at 5 miles per hour, adjusting the screw as needs indicate. In case the engine falters or drops a cylinder and the fault is not in the ignition, it may be necessary to set the speed up a bit. This is especially true in cars which have seen considerable mileage, since the vibration of the car may have worn the engine and carburetor parts to the point where they are no longer as efficient as when new.

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*The Model "T" is the Buick. These instructions are also applicable to the Nash and Hudson.

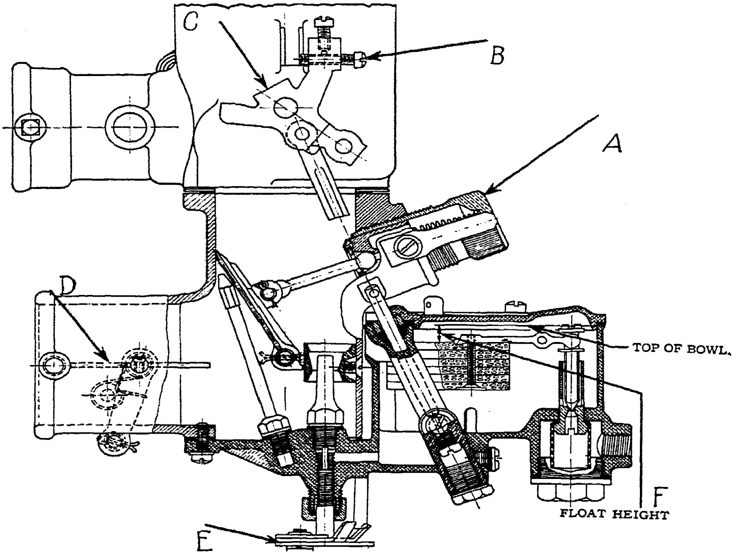


Fig. 86. Service Drawing of Model "T" Marvel
This covers many carburetors fitted to Buick, Nash, and Hudson Cars.

Final Floor Adjustment. Open up the throttle *C* quickly and then close it quickly. Note the action of the engine when it returns to idle speed. If it stops or tends to stop, it will be necessary to give the air screw a few more notches inward. A final setting of the air screw *A* will usually be found approximately even with the end of the ratchet spring bearing against it.

Choker Valve Adjustment. The choker valve *D*, Fig. 86, is a butterfly valve in the main air intake. Inspect the choker valve to see that it closes completely when the choke is worked. If it does not, adjust the control so that it will close completely, otherwise hard starting will be encountered, especially in cold weather with a cold engine. Make a final inspection to see that it opens fully to the position shown in the dotted line at *D* and see that the choker valve is tight on its shaft.

Gasoline Level. The gasoline level is controlled by the float mechanism, the float itself being of cork construction. Inspect the float, in case of trouble, to see whether it is in good condition. If it is not, it should be replaced with a new one. The dimensions for the float height are as follows. In the case of the die-cast bowl, measure $\frac{19}{64}$ inch from the top of the bowl to the top of the float at the point indicated by the arrow *F*. The dimensions in the case of the cast-brass bowl carburetor is $\frac{9}{16}$ inch.

Needle-Valve Gasoline Adjustment. Some of the later Marvel Model "T" carburetors are not equipped with a gasoline needle adjustment. Those which have this adjustment are provided with a notched device which is to be set with the notch below the indicator post, above the needle head. This should be done before adjusting the air screw. The real adjustment of the carburetor is secured by means of the air-valve screw, not by the lower needle adjustment.

Servicing Model "A" Marvel Carburetor. *Preliminary Adjustment.* Preliminary idle adjustment is secured by adjusting the brass sleeve *B*, Fig. 87. This is the air screw and by turning it outward a few notches at a time, it will be noted that the engine starts to slow down and falter. After this is noted, proceed to adjust further by turning the air-screw sleeve *B* inward a few notches at a time until a smooth and even operation of the engine is secured. As in all cases of carburetor adjustment, it is absolutely necessary to have the engine thoroughly warmed up before proceeding with this adjustment. If the adjustment is screwed in too far, the engine will start to roll and give other signs of being too rich. When the best idle speed with this adjustment is secured, it should be left at this point.

Idle-Speed Adjustment. The idle adjusting screw *D* is made so that the car, on a level road with the spark in full advanced position, idles at approximately 5 miles per hour. This screw controls the opening of the butterfly throttle. The lock screw underneath the screw *D* is loosened while turning the screw *D* in order to secure proper idle adjustment, after which the lock screw is reset so as to hold the adjustment.

Final Adjustment. When making a final check for proper adjustment, the procedure is one of quickly opening the throttle. This is done by grasping the throttle valve control *C* near the carburetor. If the engine falters and tends to stop, the air screw *B* should be turned in a few more notches. It will be found that the final setting of the air screw will be approximately even with the end of the ratchet spring and ratchets on it to prevent the air screw from coming out of adjustment when the proper adjustment has been secured.

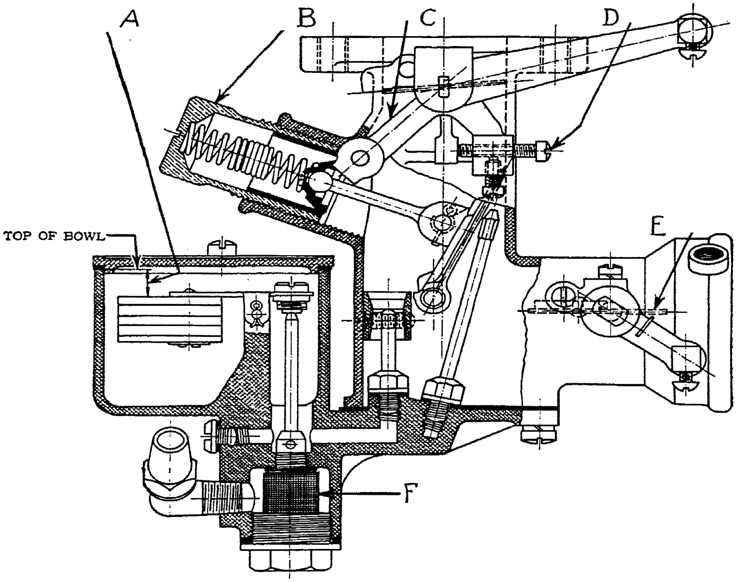


Fig. 87. Service Drawing of Model "A" Marvel Carburetor
Supplied for a large list of popular four- and six-cylinder cars.

Adjusting Float Height. If flooding occurs or if for any other reason it appears evident that the float height and the gasoline level within the float chamber are not correct, the gasoline level should be checked. The correct setting for the float is $\frac{1}{3}\frac{1}{2}$ inch from the top of the bowl to the top of the float with the float valve in its seat. Measure as indicated at *A* in Fig. 87. When inspecting the float, if there is evidence of the failure of the float or if it seems loggy, it should be replaced with a new one and then the dimensions given should be secured.

Choker Valve Adjustment. Much trouble oftentimes is encountered in carburetor adjustments which may be traced to an ineffective choker valve. This is not usually the fault of the carburetor but may be due to faulty operation of the choker-valve operating mechanism. In some cases dirt, dust, or rust prevents the proper operation of the control-valve mechanism. Two things are essential. The first is that when the choker is pulled, the butterfly valve must close fully. The second is that when the choker is pushed in, the choker valve must open fully, as shown by the dotted lines indicated by the arrow *E* in Fig. 87.

Clogged Carburetor. A clogged carburetor may be due to dirt working through the gasoline feed lines and stopping up the screen, shown by the arrow at *F*. All that is necessary to open it up is to remove the plug at the bottom and thus drop out the screen strainer, after which it may be cleaned and replaced.

Cleaning Carburetor. In some cases where gummy substances or other dirt have become lodged in the carburetor, it is necessary to completely disassemble it in order to get at the trouble and remove it. When this is found to be necessary, extreme care should be used in removing the nozzles and taking down other parts. While taking them down, inspect them for any evidence of wear. If the throttle shaft has worn badly, it should be replaced with a new one. In the case of the nozzles, use extreme care to see that they are not enlarged while being cleaned. When reassembling, be very careful to use all of the gaskets in proper position and lock all the parts down securely. Do not attempt to remove the complicated parts of a carburetor without proper equipment. In many cases this is special equipment, which may be secured only from the manufacturer of the carburetor.

PLYMOUTH CARBURETOR

Certain models of the Chrysler and DeSoto cars, as well as of the Plymouth, have used this same carburetor. It is of plain tube down-draft type, Figs. 91 and 92, with fixed jets which cover all speed ranges except the idle range which is controlled with an adjusting needle. The carburetor is equipped with an adjustable accelerating pump and a fast idle device for preventing stalling with a cold engine. For high altitudes (3000 feet and above) 5 per cent and 10 per cent leaner jets are available from the carburetor manufacturers.

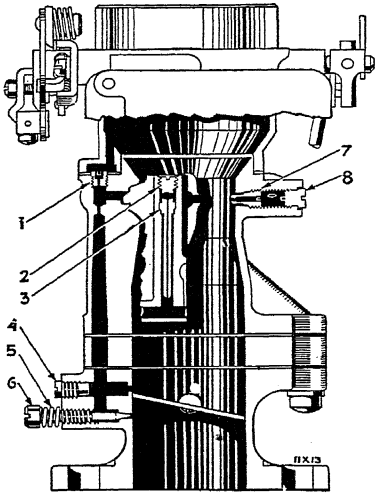


Fig. 91. Front Cross-Section of Plymouth-Chrysler Carburetor
1—Idle Vent Screw Plug. 2—Idle Orifice Plug. 3—Idle Orifice Tube. 4—Idle Hole Plug. 5—Idle Adjustment Screw Spring. 6—Idle Adjustment Screw (and Valve). 7—Pump Jet. 8—Pump Jet Plug.

Idle Adjustment. The idle adjusting screw *6*, Fig. 91, controls the fuel mixture for closed throttle running. The idle adjustment operates on an emulsion of fuel and air and therefore turning the adjusting screw clockwise gives a leaner mixture and anti-clockwise a richer mixture.

Note. Before attempting any carburetor adjustments, it is important that the breaker points and spark plugs be properly set, the ignition timing be correct, and the valve tappets have the proper clearance. Before setting the idle adjustment, the engine must be thoroughly warmed up to its normal operating temperature. With the throttle closed, and the choke in the "off" position so that the fast idle cam is thrown out of operation, turn the idle adjusting screw *6*, "in" until the engine starts to lag or run irregularly. Next turn the idle adjusting screw "out" slowly until the engine begins to roll. Next turn the adjusting screw "in" very slowly to a position between the first and second locations of the adjusting screw. When the proper idle adjustment is reached the engine should run smoothly.

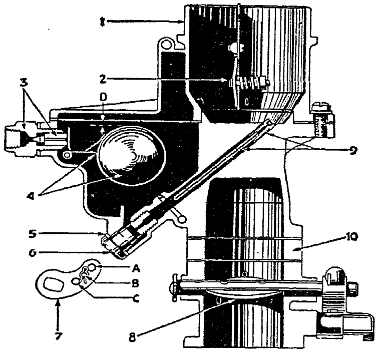


Fig. 92. Side Cross Section of Plymouth-Chrysler Carburetor

A—Accelerating Pump Winter Setting (Outer Hole, Long Stroke). B—Accelerating Pump Intermediate Setting (Center Hole). C—Accelerating Pump Summer Setting (Inner Hole, Short Stroke). D—$\frac{1}{16}$″ (1.58 mm.)

1—Air Horn Assembly. 2—Choker Valve Assembly. 3—Float Needle and Seat Assembly. 4—Float and Lever Assembly. 5—Main Metering Screw Gasket. 6—Main Metering Screw. 7—Accelerating Pump Lever. 8—Throttle Valve. 9—Main Vent Tube and Plug Assembly. 10—Body Flange Gasket (Insulator).

After setting the idle adjustment it may be necessary to readjust the throttle stop screw for the proper idling speed. If a satisfactory idling adjustment cannot be obtained, it may be due to dirt in the idling passages of the carburetor or an engine tune up may be necessary. To clean the idle passages remove the idle needle valve and the idle hole plug. Clean all passages by blowing them out with compressed air. See that the idle orifice tube *3* is clear and that it seats tightly in the carburetor body. Do not use metal or wire in cleaning jets.

Accelerating Pump. In order to provide the additional gasoline required for rapid acceleration, the carburetor is equipped with a pump which supplies an extra charge of fuel momentarily when the throttle is opened quickly. Three positions are provided on the accelerator pump lever in order to give a greater or less discharge of gasoline, depending upon climatic conditions.

For extremely warm weather or for high altitudes (above 3000 feet) the accelerating pump link should be placed in the hole *C*, Fig. 92, in the accelerating pump lever *7*, which is closest to the pump lever shaft. This gives the shortest stroke of the accelerating pump. For normal summer driving, the pump link should be in the middle hole *B*, in the lever. For extremely cold weather operation, the pump link should be in the pump lever hole *A*, which is farthest from the shaft.

Fuel Level. The fuel level in the float chamber is controlled by the position of the float. The top of the float is set 1/16 inch, dimension *D*, Fig. 92, below the surface of the float chamber (without gasket) with the engine idling. It should not be necessary to disturb this adjustment unless the float or the float arm has become damaged by rough handling. If it is necessary to correct the float level, it may be done by bending the float arm near where the arm is fastened to the float.

Fast Idle. The carburetor throttle is mechanically connected with the choke so that if the choke is more than half "on" the throttle will be opened slightly to prevent stalling when starting and warming up a cold engine. With the choke in its fully closed position, the throttle stop screw will rest on the high point of the fast idle cam.

Manifold Heat Control. The exhaust manifold on the DeLuxe "PE" Model is equipped with an automatic heat control, Fig. 93, which regulates the amount of heat by-passed around the inlet manifold heater body. The operation of the heat control on the DeLuxe "PE" Model is fully automatic and no adjustments are required. The heater valve plate *9*, valve plate shaft, and bushings are made of special metals which will not corrode, thereby eliminating the possibility of the valve sticking. An occasional check should be made to insure that the valve is free and is not restricted in its operation.

When installing a new thermostat, it should be placed on the heat control shaft in the position illustrated at *A*, Fig. 93, and then turned 200 degrees and the end of the thermostat *1* placed under the elbow *3*. If the thermostat installation is correctly made, the heat control counterweight arm *4* will be back against its stop *2*, as shown in the illustration, when the manifold is cool.

The "PF" Model is equipped with a manually adjusted heat control, Fig. 93A. For cold weather operation, the stud nut *7*, on the adjusting plate *1*, located on the exhaust manifold, should be loosened and the plate turned in the direction of the arrow, Fig. 93A to the "on" position. This will place the word "off" under the lock nut. The nut should then be tightened. For high speed driving conditions, the manifold heat control should always be set in the "off" position.

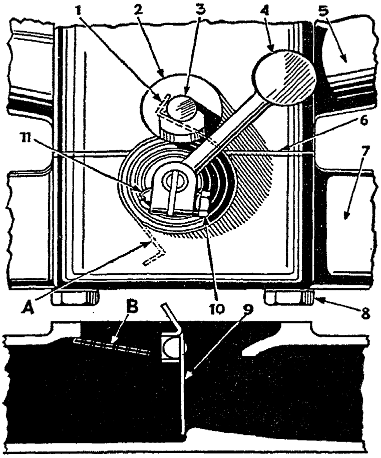


Fig. 93. Automatic Manifold Heat Control Valve and Thermostat (DeLuxe, PE Model)
1—Thermostat. 2—Manifold Heat Control Valve Stop. 3—Intake Manifold Drain Tube Elbow. 4—Manifold Heat Control Valve Counterweight. 5—Manifold Assembly. 6—Intake to Exhaust Manifold Gasket. 7—Manifold Assembly. 8—Intake to Exhaust Manifold Screw. 9—Manifold Heat Control Valve Plate. 10—Manifold Heat Control Valve Counterweight Bolt Nut. 11—Manifold Heat Control Valve Counterweight Bolt.

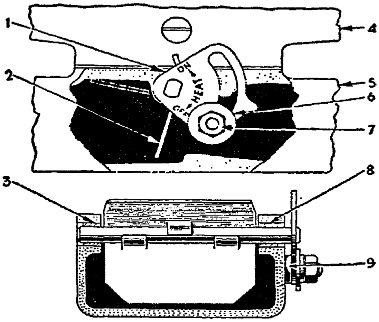


Fig. 93A. Seasonal Manifold Heat Control (PF Model)
1—Heat Control Valve Shaft and Adjusting Plate On Position. 2—Heat Control Valve Shaft Adjusting Plate. 3—Heat Control Valve Shaft Bushing. 4—Intake Manifold. 5—Exhaust Manifold. 6—Heat Control Valve Adjusting Plate Washer. 7—Heat Control Valve Adjusting Plate Stud Nut. 8—Heat Control Valve Shaft Bushing. 9—Heat Control Valve Adjusting Plate Spacer.

Exhaust Pipe, Muffler, and Tail Pipe. The exhaust pipe, or vaporized and carried back into the intake manifold in such condition that it may be burned.

Primary Air. The primary air which is used to pick up the fuel from the main nozzle in the venturi enters around the rim of the cup marked *6*. From this point it travels downward around the lower edge of the venturi and then upward through the venturi where it picks up the gasoline from the main nozzle.

High-Speed Adjustment. The high-speed adjustment nozzle, shown at *7* in Fig. 96, is used to regulate the amount of gasoline throughout the entire driving range above the 10-mile per hour, which is controlled by the idle-adjusting screw. In order to secure an adjustment of this screw, it should be turned "in" to make the adjustment lean and "out" to enrich it. By studying Fig. 96 it will be seen that when the screw *7* is turned in, it closes off or calibrates the opening more closely. As it is turned out, more gas is permitted to flow. The carburetor is so designed that an extreme amount of gasoline cannot be drawn through the calibrated opening even though the needle be opened an unwarranted amount. In the case of very high test fuel, the needle should be readjusted in order to secure economy. The normal setting for the high-speed adjustment is approximately twelve notches out or open.

Cleaning Carburetor. It is recommended that every 3,000 miles the screw marked *10* be removed for cleaning the carburetor. This will allow the gasoline bowl to be removed and the strainer housing and strainer may be removed for cleaning. In case the strainer has become damaged or is not effective, dirt may have worked into the carburetor and stopped up the drilled passages. In such cases it will be necessary to remove the carburetor and completely disassemble so as to get at these small openings and clean them. Be very careful not to enlarge the openings when cleaning them as this will destroy the effectiveness of the device.

WINFIELD CARBURETOR

The Winfield carburetor is of the plain-tube two-stage type with fixed sizes for all gasoline orifices and air passages. The delivery of the correct amount of gas for any engine speed or engine load is controlled and governed by the velocity of the air stream and the corresponding vacuum. For this reason a Winfield is free from all moving mechanical parts such as cams, valves, pumps, and other metering devices. The throttle is the only moving part aside from the float mechanism and the choke.

Cylinder Throttle. The cylinder throttle, Fig. 100, serves a double purpose. First, the simple function of a throttle; and second, and of great advantage, as a variable venturi—a venturi that gives correct efficiency for any throttle opening. This throttle gives a very high velocity to the air stream at closed or semiclosed throttle position. As the throttle opens, it allows more air to enter—naturally at a decreasing velocity. This is a desirable condition for both low- and high-speed range. Furthermore, this throttle has another advantage—it allows a free, open, and unrestricted passageway for the air stream at wide-open throttle. The greater the volume of properly vaporized gas and air, the greater the power of the motor. This is termed volumetric efficiency.

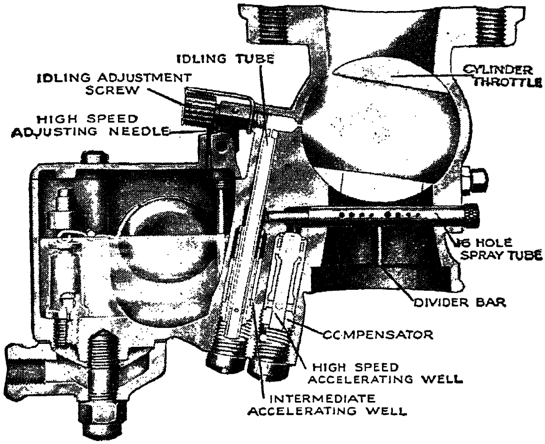


Fig. 100. Cross Sectioned View of Winfield Carburetor at Idling Position
Courtesy of Winfield Carburetor Company, Glendale, California

Sixteen-Hole Spray Tube. The Winfield carburetor employs a sixteen-hole spray tube, Fig. 101, in place of the conventional jet or jets. There are eight small calibrated holes on each side of this tube. The design of the tube is best understood by imagining that

Idling to Half-Open Throttle. As the throttle opens wider and off the idling position, Fig. 102, it starts to uncover the spray-tube openings. The fuel is supplied from the intermediate well and the level of gas in this well drops. As the throttle reaches about one-third to half opening, the gas which has been held in the idling by-pass tube drops and furnishes an extra supply of gas to the intermediate well. This action affords a second stage of acceleration in the intermediate range.

Half- to Wide-Open Throttle. As the throttle passes the air passage divider, which is located at the half-open position, the added fuel is supplied from the high-speed well. See Fig. 103. The level in this well drops according to the vacuum applied. When a relatively high vacuum for wide-open throttle operation is reached, the well is empty. This occurs at a speed beyond which no further well action is required and is appreciably less than full speed. If the motor were then placed under a heavy load which would pull the car down to about five miles per hour, this level would come back up to the top of the relief in the compensator. With the arrangement and design of the high-speed compensator, there are two stages of synchronized acceleration in this well.

Installation. The Winfield carburetor is adaptable to any type of engine or special cylinder head, as shown in Fig. 104. Special adapting flanges are often necessary to make the installation, and to this end the factory makes up special package installations that are complete for each model and make of motor.

Servicing Winfield Carburetor. There are only three adjustments to make. There are no fixed jets or orifices to change. The "throttle cover side" refers to the side of the carburetor on which the throttle cover is held by three screws. The opposite side of the carburetor is referred to as the "body side."

After removing the old carburetor, take a file and clean the manifold flange. Have the manifold flange smooth and clean. When installing the carburetor be sure to use the new gasket which is furnished with this installation. Never use a gasket that is over $\frac{1}{64}$ inch thick. A thick gasket often warps the carburetor flange and this warping will cause an air leak that results in poor idling and poor low-speed performance. Above all, never use shellac or any other preparation on the gasket.

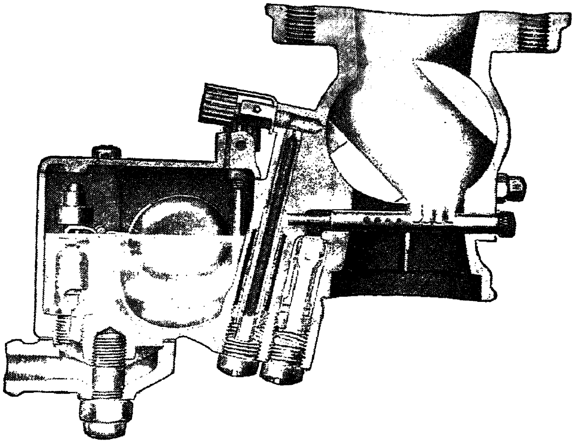


Fig. 102. Cross Sectioned View of Winfield Carburetor at One-Half Open Thrott
Courtesy of Winfield Carburetor Company, Glendale, California

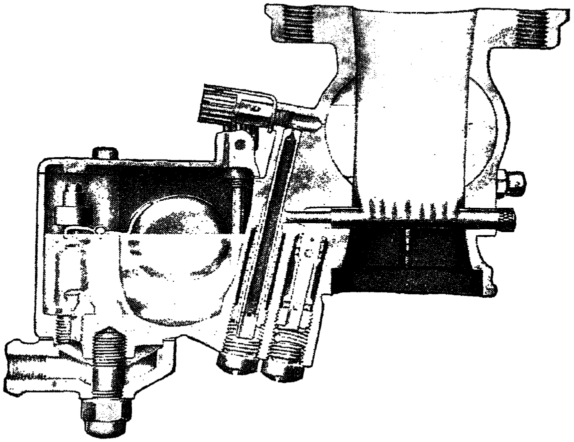


Fig. 103. Cross Sectioned View of Winfield Carburetor at Wide-Open Throttle
Courtesy of Winfield Carburetor Company, Glendale, California

until they just barely seat. **Do not screw these needles down too tight** because too much force will distort the float bowl cover and gouge out the needle seat. Turn them down just to the point where there is a slight resistance.

Intermediate Adjustment. The intermediate speed or economy adjustment is controlled by the needle adjacent to the mark "INT" on the float cover. Turning this needle up in an anticlockwise direction gives more gasoline. Open this needle two full turns—there are 16 notches to each turn. To obtain an exact adjustment, advance the spark lever to normal driving position, set the throttle hand lever on the steering wheel to a position which is about one-third open, then screw this needle down until the motor slows down. Then open this needle one notch at a time until the motor attains its maximum speed with minimum opening of the intermediate needle. This should give you a good average adjustment. Two notches less opening may give your customer better economy for continuous driving or touring.

To check this adjustment, screw the intermediate adjustment down two notches. If the motor slows down just slightly, the former setting was correct. Screw the needle up and back to its original setting. If the motor does not slow down when the needle is turned down two notches, it is adjusted too rich. In this case continue to turn the needle down until reaching the point where there is a slight slowing down of the motor, then back two notches.

High-Speed Adjustment. Turn the high-speed adjustment needle up in a counterclockwise direction to the same number of notches as the setting for the intermediate needle. There is only one way to make this setting correctly and that is to try the car out on the road—preferably on a hill. Run the car at wide-open throttle and see how it performs. Then open the high-speed adjustment needle up two notches at a time to see if there is an increase in power. Repeat this operation. When the point is reached where there is no additional increase in power, it is advisable to turn the needle back two notches.

If the high-speed adjustment is adjusted too lean, the motor will hesitate and will not pick up to its maximum speed at wide-open throttle. If the adjustment is too rich, the motor will be sluggish, that is, it will be slow in getting under way.

Float Level. The float level on a Winfield carburetor should be $^{13}/_{16}$ inch from the top surface of the float bowl. This measurement must not be made along the side of the bowl because the capillary action holds the gas up on the side of the bowl.

Oil Throttle Bearings. While the motor is idling, oil both ends of the throttle shaft at the throttle bearings with ordinary engine oil. Repeat this operation every 500 miles.

Caution. The carburetor does not change in adjustment. Once it is correctly set, it should then be left alone. If the motor starts to miss and act improperly, first check the ignition carefully. Then check the gasoline lines and vacuum tank or fuel pump. Then drop the strainer bowl of the carburetor and clean the strainer screen with compressed air. Be careful not to damage this fine mesh screen. Put the strainer bowl back again and see if the motor does not again function properly.

BUICK-STROMBERG A-A CARBURETOR

The Stromberg Series A-A carburetor is of the duplex downdraft type of aircraft design. It has been adopted as standard equipment for a number of production cars. The model is used on all Buick cars for 1937. The Buick model is described here, but the reader needs to remember that while the general principle of operation of all of the A-A Series is quite similar, there must be certain minor differences in the different models supplied to different cars. Engines with larger displacement require more fuel than engines with a smaller displacement. Inherent characteristics of engine design also must be met and satisfied by carburetor design, so that uniform power curves as representing engine performance may be developed by the engineers. However, the service man is interested primarily in knowing the fundamental features of construction and adjustment. The principle of operation of the A-A carburetor is the plain tube using air-bled jet to maintain the proper mixture throughout the entire range of operation. A study of Figs. 105 to 107 will show that the fuel chamber completely surrounds the entire carburetor body. This feature is incorporated in order to insure a proper level of fuel under varying conditions of operation. Baffles are supplied in the float chambers designed to prevent undue surging of the fuel on sharp, sudden turns. The float lever is so connected to plied through the economizer valve. An accelerating pump is connected directly to the throttle and this taken in connection with the economizer tends to assure proper engine performance under all operating conditions.

Main Metering System. With the engine turned over by the starting motor, fuel is forced through the fuel line from the fuel pump into the carburetor bowl. The float needle valve *18,* Fig. 107, and the float needle valve *19* in connection with the float maintains the fuel at a constant level.

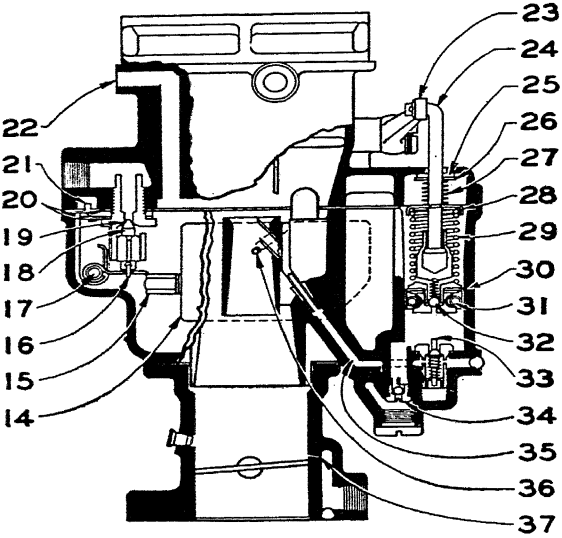


Fig. 107. Buick-Stromberg Carburetor Showing Accelerator Well and Pump

The choke appears as *1* in Fig. 105, and the throttle butterfly valve is indicated as *11* at the bottom of the carburetor barrel, two of these being used — one in each barrel. Since this is a down-draft carburetor, air enters at the top through the air inlet and when passing downward through the carburetor places suction on the main discharge jet *2* or the idle discharge holes *10* depending upon the amount of throttle opening. The main metering jets *5* are of the fixed type. They control the flow of gas during the intermediate or part throttle position up to approximately 75 miles per hour. After being drawn from the metering jet, the fuel passes to the main discharge jet *2* where it is mixed with the air from the high-speed bleeder *3* and flows into the carburetor barrel down to the intake manifold.

The intake manifolds of the Buick engines are of the twin type integrally cast. The outside branch of the manifold supplies cylinders 1, 2, 7, and 8 and the inside branch supplies cylinders 3, 4, 5, and 6. An exhaust jacket is cast around the center section and is connected with the exhaust system, this being designed to assist carburetion by the addition of heat to the incoming fuel as it contacts the heated walls of the manifold. More complete instructions on this feature are given in the section describing manifolds.

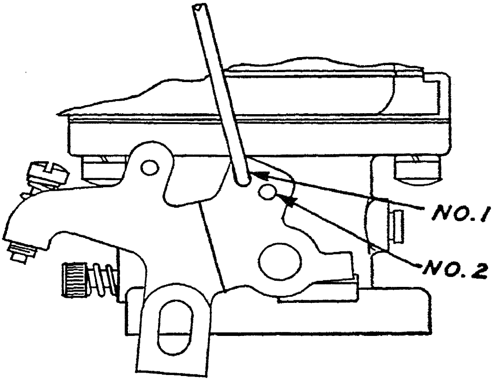


Fig. 108. Buick Accelerating Pump Rod Adjustment

The reader should note that all jets as supplied by the factory are of the proper size for usual operating conditions and it is not recommended that any changes be made in these jet sizes without special instructions from the factory.

Maximum Power. For a part throttle opening, fuel is supplied through the main metering jet to approximately 75 miles per hour, at which point the economizer valve *33*, Fig. 107, is forced down by the accelerating pump piston allowing fuel to flow through the economizer valve and discharging through the pump discharge nozzle *36*. Fuel is supplied continuously through these passages position of the level before the carburetor is removed and disassembled. It should seldom be necessary to make a change in the fuel level, but if it does become necessary and the inspection shows the need of such change, the level is secured by bending the float lever arm so as to secure the level desired. It is important to remember that the float level must be checked only while the engine is running.

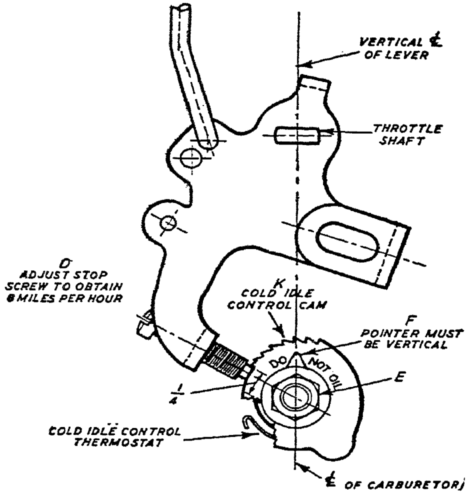


Fig. 109. Buick Cold Idle Control

Cold Idle Control. The cold idle control is designed to provide a faster idle speed during the warm-up period of the engine which insures adequate lubrication for the engine and prevents stalling. The speed of the engine increases or decreases as the temperature of the manifold changes. The cold idle control consists of a thermostatically operated cam *K*, which is shown in Fig. 109. This is mounted on the intake manifold heat jacket. This cam serves as a stop for the throttle stop screw *D*. The variable speed mentioned is secured by using the thermostat *A*, which drives the cam *K*. When the riser is cold, the thermostat *A* rotates the cam *K* in a counter-clock-wise direction, causing its thick side to contact with the idle stop screw *D*, which serves to speed up the engine. Now as the riser warms up, the thermostat is heated and thus revolves the cam *K* in a clock-wise direction until the idle screw *D* is contacting with the cam *K* at its thinnest section, causing the carburetor throttle to close to the normal, hot idle speed. Ordinarily it will not be necessary to adjust the cold idle control. However, it may be checked by loosening the nut *E* and rotating the cam hub in the direction necessary to place the pointer *F* directly above the nut *E*. This adjustment may be made regardless of the manifold temperature. A momentary opening of the throttle is necessary to allow the cam *K* to adjust itself for any temperature position. This is because the spring *A* is not capable of rotating the cam *K* while the idle adjusting screw is contacting the cam. After the engine has been warmed up, the throttle stop screw *D* should now contact the cam *K* on its thin portion, and within the $\frac{1}{4}$-inch limit adjoining the first raised section of the cam as shown in Fig. 109. In case the throttle stop screw does not contact within the limits shown, the cam hub with the pointer attached may be rotated slightly in order to bring the $\frac{1}{4}$-inch section under the idle screw. If it is necessary to rotate the pointer more than 5 degrees from its former vertical position, a complete new cam assembly should be installed. It is important to see that no oil is used on the cold idle cam.

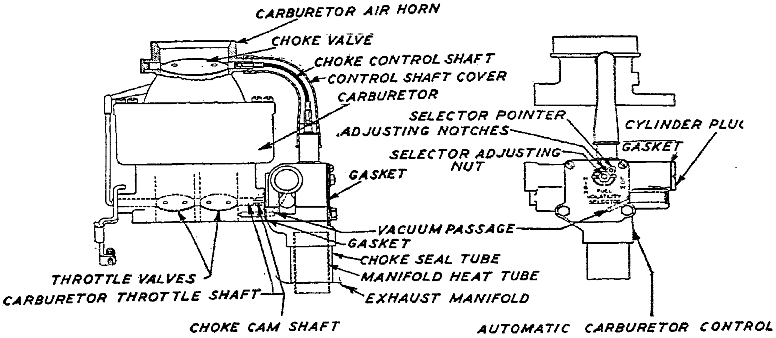


Fig. 110. Delco-Remy Automatic Opposed Piston Type Carburetor Control

Proper Idle Speed Important. The idle speed of 7 to 8 miles "take-off" spring. As the amount of vacuum increases, the take-off piston is pulled back in its cylinder accordingly. This movement is retarded to some extent due to the action of the dashpot piston which is secured to the opposite end of the connecting rod. The movement of the "take-off" piston and dashpot piston is transmitted to the thermostat through a gear and rack arrangement, Fig. 112. Thus, any movement is transmitted through the thermostat and shaft directly to the choke valve.

Carburetor Air Inlet Velocities. As the engine starts to run, the increased air flow through the carburetor air horn tends to open the unbalanced choke valve. The air velocities on the unbalanced choke valve correct the mixture for varying engine speeds.

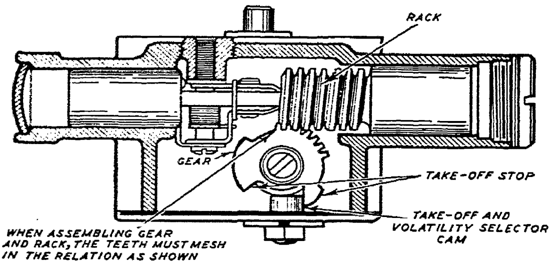

RACK
GEAR
TAKE-OFF STOP
TAKE-OFF AND VOLATILITY SELECTOR CAM
WHEN ASSEMBLING GEAR AND RACK, THE TEETH MUST MESH IN THE RELATION AS SHOWN

Fig. 112. Delco-Remy Rack and Gear

Throttle Opening. The carburetor throttle shaft is connected directly to the choke camshaft, as shown in Fig. 110. Thus, the movement of the throttle is transmitted through the choke camshaft, throttle cam, cam roller, and pull-out lever to the connecting rod and linkage between the "take-off" piston and dashpot piston. The movement somewhat modified by the other controlling factors, according to operating conditions, passes through the gear and rack, thermostat and shaft to the choke valve. This action is not transmitted to the choke valve immediately due to the retarding action of the dashpot piston. The movement of the throttle cam loads the pull-out lever spring and the tension of this spring on the pull-out lever gradually moves the dashpot piston forward in its cylinder. See Fig. 111. The port hole in the dashpot piston cylinder allows this action to speed up after the piston has reached this point. The full movement of the dashpot piston is completed in 7 to 10 seconds. The return of the piston to its original position requires a maximum of one minute.

In the above discussion the operation of each individual part of the control has been covered. When the engine is in operation the amount of "choke" obtained at any one instant is a combination of the above features.

Starting the Engine and the "Warm-Up" Period. When the engine is not running, the choke valve is positioned by the thermostatic spring according to temperature. At 85 degrees Fahrenheit or below, the choke valve is closed. As the starter pedal is depressed, closing the starting motor contacts and opening the throttle, the "choking" action is quite heavy depending on the temperature. By this action enough fuel is injected into the cylinders to insure easy starting. Under ordinary conditions the engine will start in 1 to 3 seconds. As the engine fires and continues to run the increased heat on the thermostatic coil, the greater air velocity through the carburetor air horn, and the increased vacuum in the take-off piston cylinder all tend to open the "choke" valve and decrease the amount of "choke." If the motor is accelerated or pulled heavily during the warm-up period, the variation in vacuum, air velocity, and throttle position operate the various parts of the control so that the choke valve is positioned correctly. As the temperature increases and the desirability of a richer mixture decreases, the thermostatic spring opens the choke valve more and more until the wide open position is reached. The engine is now at normal operating temperature and the control has no further function until the engine is stopped again.

Since the throttle and starter switch are actuated by the same foot pedal, the connection of the choke mechanism with the throttle shaft provides desirable starting features especially in cold weather. These features are as follows: delayed dechoking with wide open throttle, and ability to "lug" or pull the engine cold indefinitely without upsetting the correct mixture ratio.

Delayed Dechoking with Wide Open Throttle. When the engine does not start immediately and prolonged or repeated cranking is necessary, it becomes important that a dechoking action take the moving parts as shown in Fig. 111. It is very important that moving parts be free and that pistons are clean and do not stick in the cylinders.

The "take-off" and dashpot piston assembly can be removed without disturbing the thermostatic calibration if the proper procedure is followed. Remove the dashpot pull-out lever by removing its pivot screw. Remove the take-off cylinder plug and take-off piston spring. The piston assembly can then be pushed toward the open end until the rack and gear disengage. The thermostat shaft and gear assembly can then be turned approximately 180 degrees so that the dashpot piston will clear the gear as it is pulled out through the "take-off" cylinder. Looking through the thermostat opening in the bottom of the casting will assist in this operation as care should be taken not to scratch the dashpot piston as it passes the gear.

If the pistons are dirty or sticky, they should be wiped off with a clean soft cloth. The cylinders should be carefully wiped out with alcohol, if necessary, and should be thoroughly dry before reassembly. Check the flexible linkage between the two pistons for free operation at both ends. While the pistons are removed, rotate the thermostat shaft and gear assembly to be sure it is free in its bearings.

Before reassembling be sure that the vaccum passages in the choke casting and carburetor throttle body are open. The use of compressed air is satisfactory for this purpose if the air system is entirely free from water, oil, and rust; otherwise it may be very harmful.

TILLOTSON CARBURETOR

Arrangement of Nozzles and Functioning Parts. There are two sources of mixture delivery. At *A*, Fig. 114, is the by-pass or low-speed nozzle tube and at *B* the main or high-speed nozzle. Gasoline enters the carburetor through connection *C*, passes the strainer *D* and the inlet needle valve *E*, from whence it delivers into the float bowl chamber *F*. When the fuel reaches a point $\frac{13}{16}$ inch from the top edge of the float bowl, the float acts upon the needle *G*, closing off the supply. From the float bowl, the gasoline enters channel *H*, flows upward through the main nozzle adjustment restriction *I*, across channels *J* to the head of the by-pass nozzle and into the accelerating well above at *K*, seeking by gravity the same level held in the float bowl. It being important to the function of the carburetor that the fuel level be carefully maintained, close study should be made of the chamber and channels filled with gasoline, noting especially where fuel is present and where there is none.

Operation of Low Speed and By-Pass. As the engine is revolved in the operation of starting, the suction induced by the reciprocation of the pistons within the cylinders, timed by valves in the poppet type of motor, creates a vacuum above the throttle shutter. Connecting the throat above the shutter with the by-pass mixing chamber *M* is a small hole at *L*, Fig. 114. Suction induces an emulsion of gasoline and air to pass upward through the by-pass tube to the mixing chamber *M* where air is again admitted through low-speed adjustment *KS*, causing the emulsion to be turbulated and drawn through hole *L* at high velocity. Thus the idling mixture requirements are satisfied.

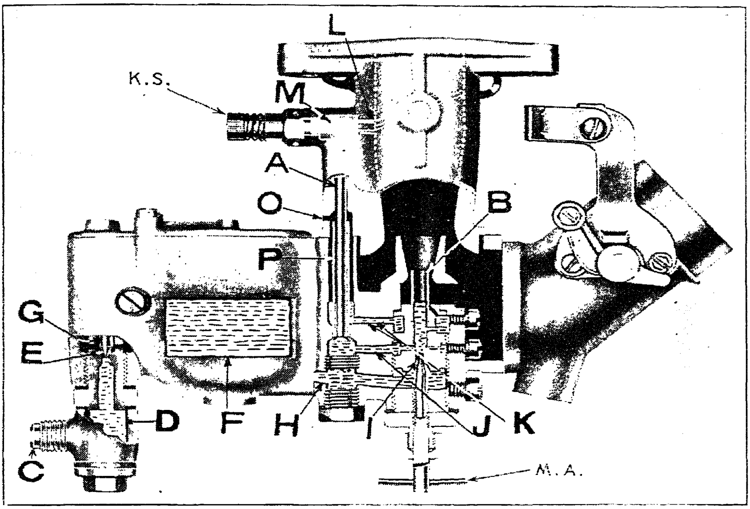


Fig. 114. Cross Section of Nozzles and Other Constructional Features of the Tillotson "S-4D" Carburetor

FORD "V-8" DUAL CARBURETOR AND MANIFOLD

Ford "V-8" Dual Manifold. The 1934 passenger cars were the first to be equipped with a dual down-draft carburetor, Fig. 117,

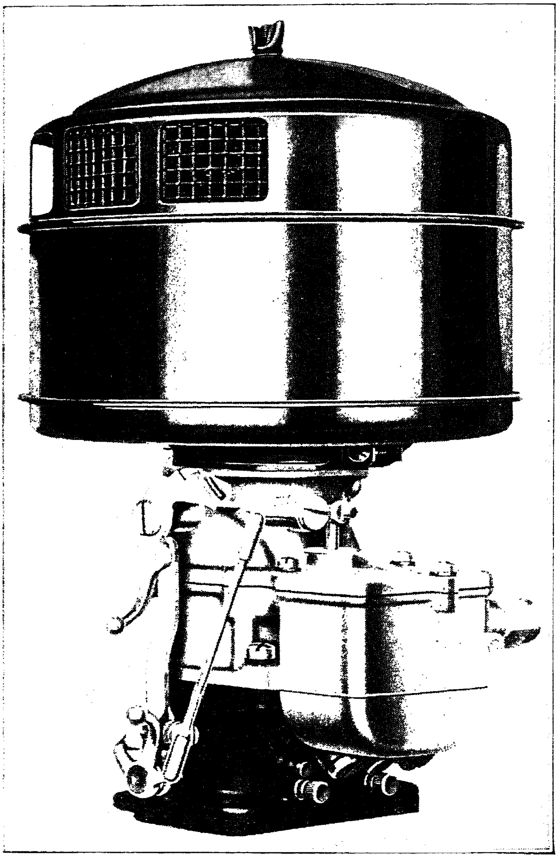


Fig. 117. Ford "V-8" Carburetor and Air Cleaner

and dual intake manifold, which give the same results as would be obtained from two separate 4-cylinder manifolds and carburetors. Fig. 118 shows the intake manifold for the right-hand barrel of the dual carburetor in heavy lines. This portion of the intake manifold supplies the fuel-air mixture to cylinders *1*, *4*, *6*, and *7*. Fig. 119 illustrates the intake manifold for the left-hand barrel of the carburetor which supplies the fuel-air mixture to cylinders *5*, *8*, *3*, and *2*.

With the exception of a small passage-way between the two manifold cores, at the windshield wiper and distributor vacuum brake connections, the two intake manifolds are entirely independent of each other and not connected. These connecting passage-ways at the windshield wiper and distributor vacuum brake connections serve the purpose of steadying the vacuum at these points, giving the steady vacuum characteristics of an 8-cylinder engine. If these two manifolds had not been connected at these points, the vaccum for the windshield wiper and the distributor vacuum brake would be unsteady at low speeds, as with 4-cylinder engines. The use of this type of manifolding increases the power output and makes for more even engine operation.

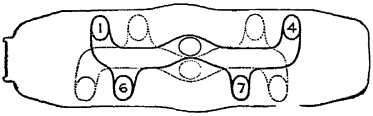


Fig. 118. Firing Order—Right-Hand Barrel of Carburetor

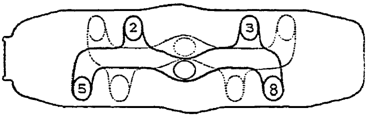


Fig. 119. Firing Order—Left-Hand Barrel of Carburetor

Ford "V-8" Dual Carburetor. The dual carburetor, Fig. 117, used on 1934 Ford "V-8" cars, uses one float chamber and float valve, one choke valve, and one accelerating pump. The discharge, however, from the accelerating pump is equally divided between the two carburetor barrels. To simplify the carburetor explanation, the one barrel of the carburetor only will be explained, as the operation of both is identical.

Idling—Fuel Supply. The fuel from the carburetor bowl passes through the main metering jet and is drawn upward as indicated by the arrows in Fig. 120. Air enters this gasoline stream from the carburetor throat, as shown. This mixture or emulsion of gasoline and air then travels downward to the idle discharge holes.

In normal operation, with the throttle closed to the correct throttle plate position for idling, as indicated by the dotted lines in

Fig. 120 (speed equivalent to from 5 to 7 miles per hour), the lower discharge hole only is subjected to intake manifold vacuum. The other idle discharge hole being above the throttle plate is not affected by this intake manifold vacuum and for this reason does not discharge any fuel with the throttle in this position. The lower idle discharge holes are provided with a means of adjustment (see fuel idle adjustment, Fig. 120).

Choke. The carburetor is provided with an unbalanced choke valve, into which has been incorporated an air bleeder or poppet valve. When the carburetor is choked, the throttle plate is automatically open to the correct position for starting. For this reason it is neither necessary nor desirable for the operator to pull out the throttle button when starting. Fig. 120 illustrates the throttle plate position while the carburetor is choked. In this position the throttle plate is directly opposite the upper idle discharge hole and the stream of air passing around the throttle plate draws the fuel from both upper and lower discharge holes, whereas, in the normal idling position, as indicated by the dotted line, the fuel is drawn from the lower discharge hole only.

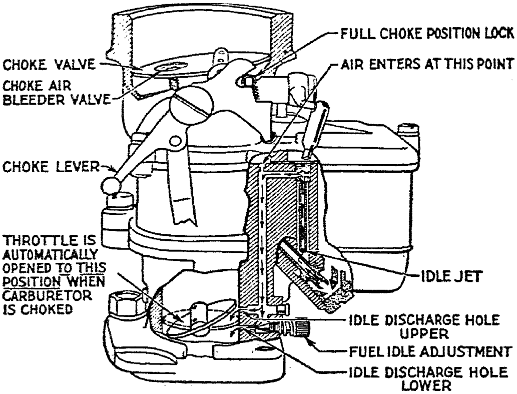

FULL CHOKE POSITION LOCK
AIR ENTERS AT THIS POINT
CHOKE VALVE
CHOKE AIR BLEEDER VALVE
CHOKE LEVER
THROTTLE IS AUTOMATICALLY OPENED TO THIS POSITION WHEN CARBURETOR IS CHOKED
IDLE JET
IDLE DISCHARGE HOLE UPPER
FUEL IDLE ADJUSTMENT
IDLE DISCHARGE HOLE LOWER

Fig. 120. Ford "V-8" Carburetor

While the idle discharge holes both supply fuel when the carburetor is choked, the main discharge nozzle, Fig. 121, supplies the bulk of the fuel in full choke position. When the carburetor is fully choked everything below the choke valve is subjected to intake manifold vacuum and all fuel discharge openings (except pump discharge nozzle) supply fuel. However, when the carburetor is not choked, the entire fuel supply for the engine for all speeds up to 25 miles per hour, is supplied from these idle discharge holes.

The choke butterfly valve has been mounted off-center so that, with the exception of the full choke position, the air flow through the carburetor throat has a tendency to push the choke valve open. However, this does not necessarily mean that the car can or should be continuously operated with the choke button in part choke position. Continued operation with the choke button out will result in an over-rich mixture and crank-case dilution. However, the unbalanced mounting of the choke valve lessens the possibility of carburetor flooding, even where the operator neglects to push the choke button all the way in. In full choke position, the choke valve is held firmly in place and a lock is provided to prevent the air stream from opening the choke valve. To supply the necessary air to the carburetor, an air bleeder or poppet valve has been built into the choke plate which, as the vacuum in the carburetor throat increases, will open.

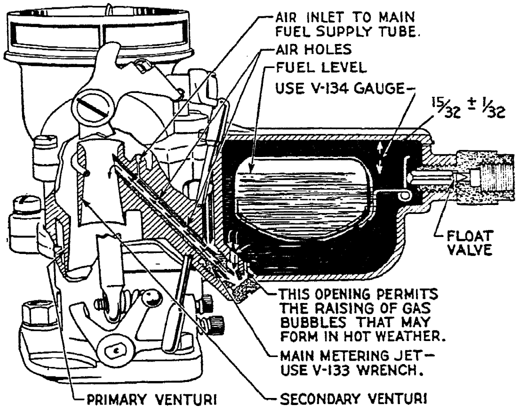

AIR INLET TO MAIN FUEL SUPPLY TUBE.
AIR HOLES
FUEL LEVEL
USE V-134 GAUGE
15/32 ± 1/32
FLOAT VALVE
THIS OPENING PERMITS THE RAISING OF GAS BUBBLES THAT MAY FORM IN HOT WEATHER.
MAIN METERING JET—USE V-133 WRENCH.
PRIMARY VENTURI
SECONDARY VENTURI

Fig. 121. Sectional View of Ford "V-8" Carburetor

The opening of this poppet valve and the rush of air flowing through it makes considerable noise. This should attract the owner's attention to the fact that the choke button is out and will continue to make this noise until the choke button is pushed all the way in or to a part choke position. The choke button should be pushed all the way in as soon as the engine has warmed up sufficiently to permit it to run smoothly on a normal mixture.

Main Fuel Supply. Starting at a speed of approximately 25 miles per hour, the main fuel supply discharge nozzle supplies all the fuel on up to approximately 75 miles per hour, at which time the by-pass or power jet also cuts in. The fuel, as was the case with the idling fuel supply, passes through the main metering jet. From this jet the fuel travels upward on an angle to the main discharge nozzle in the secondary venturi, as shown in Fig. 121. A slightly smaller jet, "40-9533C" is available for operations in high altitude.

As fuel is drawn from the main fuel supply tube, the idling fuel supply passages are emptied into this main fuel supply tube. As soon as the idling fuel supply tubes are emptied, the air entering at the air opening in the carburetor throat completely surrounds the main fuel supply tubes and is fed in small bubbles into the fuel stream. This feeding of small air bubbles into the fuel stream at several places forms an emulsion of the fuel, making the fuel lighter in weight and more responsive to throttle plate movement.

The venturi designated as the primary venturi, Fig. 121, increases the rate or speed of the air flow. The secondary venturi, opening as it does, above this restriction, and discharging below the point of greatest restriction in the primary venturi, takes full advantage of the unbalanced pressures, or the difference in pressure at the two ends of the secondary venturi, namely atmospheric pressure at the upper end, and the stepped-up vacuum at the lower end. In this way an even higher velocity for the air stream is obtained in the secondary venturi.

Float Level. As indicated in Fig. 121, the correct float level for these carburetors is $\frac{15}{32}$ inch from the lower side of the float-bowl cover gasket. Since this carburetor is of the plain tube type, the float level is of more importance than it was on the air vane operated type of carburetor. However, a tolerance, either plus or minus, of $\frac{1}{32}$ inch is permissible. The correct float level is measured from the lower side of the float-bowl cover gasket and should be not more than $\frac{1}{2}$ inch and not less than $\frac{7}{16}$ inch.

Accelerating Pump. An accelerating pump is provided to slightly enrich the mixture for rapid acceleration. Movement of either the foot or hand throttle causes movement of the accelerating pump. An accelerating pump inlet check valve is provided to prevent the accelerating pump from pumping the fuel back into the float bowl, Fig. 122. The pressure on the gasoline, exerted by the accelerating pump in its downward movement, opens the spring loaded valve directly beneath the spring loaded valve which is directly beneath the piston, and permits the gasoline to be forced out through the accelerating pump discharge tube and nozzle. However, a restriction has been provided to meter the gasoline and minimize the possibility of flooding.

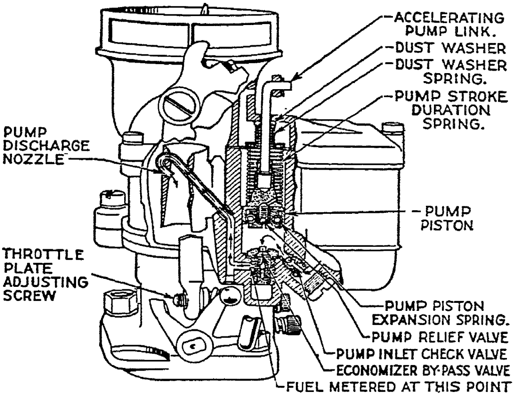


Fig. 122. Accelerating Pump of Ford "V-8" Carburetor

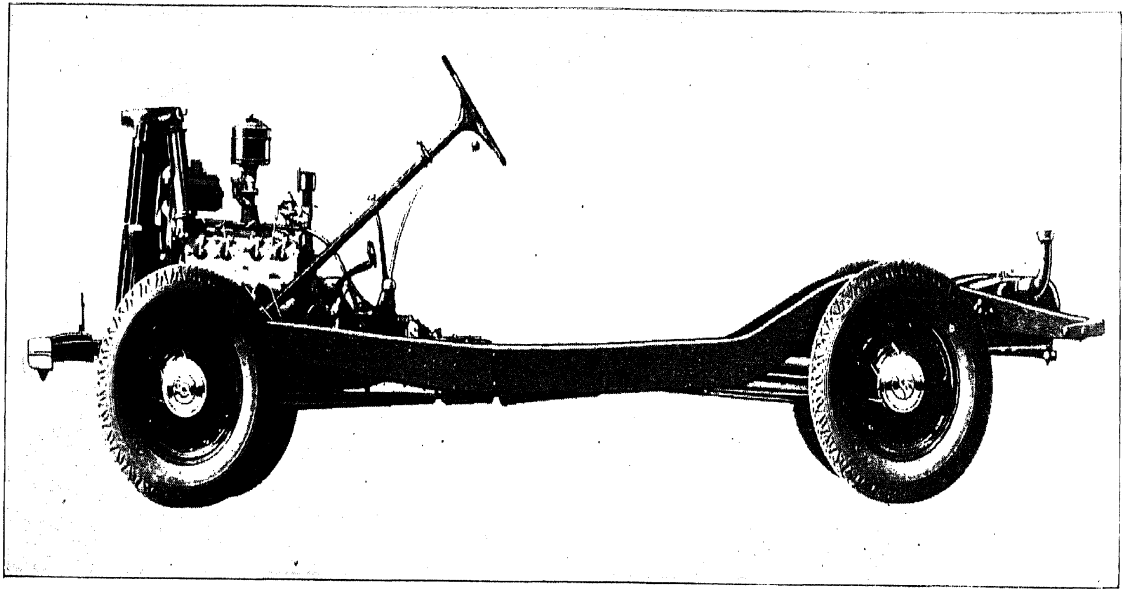
When the movement of the accelerating pump piston is too rapid to permit the flow of the gasoline through the restriction, the accelerating pump stroke duration spring is compressed. In this way the pressure exerted by the accelerating pump can never be in excess of the tension of the accelerating pump stroke duration spring.

When the throttle is completely open, the accelerating pump has moved to the bottom of its stroke, mechanically opening the economizer by-pass valve, at which time the economizer by-pass becomes a power jet, and the restriction already mentioned becomes the metering point for the flow of fuel. This power jet cuts in at about 75 miles per hour, or at a throttle position under heavy load conditions, equivalent to 75 miles per hour on level roads with the passenger car.

Servicing. With the exception of the idle speed adjustment and the throttle-plate position adjustment for idling speeds, the carburetor is entirely automatic in action and will require no attention, other than the keeping of the various passage ways clear and free from obstruction. However, it is possible, with dirty gasoline, for small particles of dust to enter and become wedged in the various metering orifices, restricting the flow of gasoline and resulting in a lean gasoline-air mixture. The remedy for this condition is to remove various jets and force a stream of compressed air through the opening to remove any foreign bodies that may have lodged in them.

Both idle jets, both main fuel-supply jets and the power jet, as well as the check valve and all passageways, should be cleaned in this manner. The fuel pump screen and sediment chamber should also be cleaned. A suitable special socket wrench, "V-133," for the main fuel-supply jets has been developed. Never attempt to clean carburetor jets by running a wire through them. This practice will result in an enlarging of the fuel orifice, with the result that the carburetor mixture will be enriched and become unbalanced. A carburetor mixture either too rich or too lean, will result in high gasoline consumption. The carburetor is adjusted on each car before the car leaves the factory. However, the adjustment is set on the rich side so as to compensate for a slight stiffness in the new motor. For this reason the carburetor must be readjusted after the breaking-in period. This adjustment should be made on every new Ford car at the time of the 300-mile inspection.

Adjusting. The idle speed of the engine should be set by means of the throttle-plate adjusting screw, Fig. 122, to a speed equivalent to five miles an hour. For the idle mixture adjustment, have the engine well warmed up and be sure that there are no air leaks at the intake manifold, windshield wiper, and distributor vacuum connections. The idle speed should be set as outlined above. The fuel idle-adjustment needle valves, shown in Fig. 120, control the quantity of the gasoline-air mixture for low-speed operation. The turning out of the valves gives a richer mixture. The turning in of the valves gives a leaner mixture. Adjust one side of the carburetor at a time. Turn the valve in slowly until the engine begins to lag or run irregularly, then slowly turn out until the engine begins to roll. Finally, turn in the adjustment again very slowly, just enough so that the engine runs smoothly for this speed. This adjusts the mixture for one side of the carburetor. Follow the same procedure for the other side of the carburetor. Ordinarily the correct adjustment will be with the fuel idle-adjustment screws both 5/8 to 3/4 of a turn open. It may be necessary, after making these adjustments, to reduce the engine speed back down to from five to seven miles per hour by means of the throttle-plate adjusting screw.



Ford "V-8" (Center-Poise Ride) Chassis

CARBURETORS

PART III

SCHEBLER CARBURETORS

Model "S." The discussion covering the fundamental principles of carburetion indicated that there are certain types of carburetors. The Schebler Model "S" is of the mechanical metering or measuring type. That is, it is designed to measure the gasoline used in relation to the amount of air, by mechanical means. The action is somewhat similar to that shown in Figs. 123 and 124, where we have an automatic air valve with metering pin and dashpot arrangement.

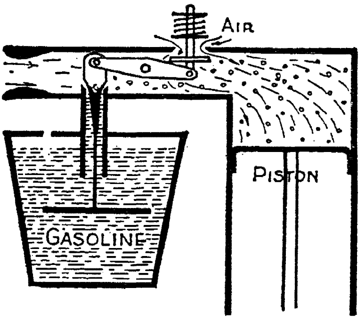


Fig. 123. Automatic Air Valve with Metering Pin and Dasher Attached

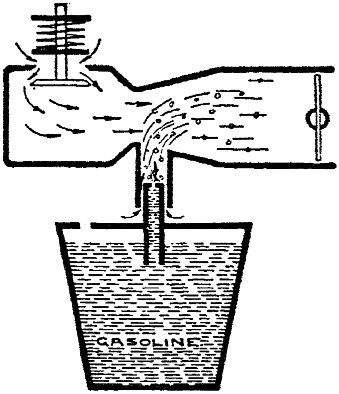


Fig. 124. The fixed air opening is so modified that it surrounds the fuel nozzle

Many cars used the Model "S" Schebler carburetor of the auxiliary air-valve type, an external view of which is shown in Fig. 125. It has been standard equipment on a number of cars. Minor variations in the different models are employed. The description of the inbuilt characteristics of this carburetor is applicable to all models.

The Schebler Model "S" is provided with an accelerating pump, shown at *C* in Fig. 128. This pump is mounted in a well which is on a level with the gasoline in the carburetor body. This well is filled through the valves and the piston of the pump. When the throttle is open, the piston within the pump is raised and the gasoline in the well is lifted ahead of it, being forced upward across and into the venturi tube at its most constricted point and just above the main gasoline jet. This passage is illustrated in Fig. 128. Air rushing in through the fixed air opening picks up and atomizes this fuel and it is mixed with the auxiliary air and carried on past the throttle into the engine to be used in the accelerating operation. In case too much gasoline is provided by the accelerating pump, that is, more than is needed for proper acceleration, the extra amount will pass through the overflow hole provided at *D* and thence be returned to the supply in the body of the carburetor so that it is not wasted. This overflow hole is adjusted for size and position when fitting a carburetor to an engine. By this arrangement just the proper amount of gasoline is sent through to care for the demands of acceleration.

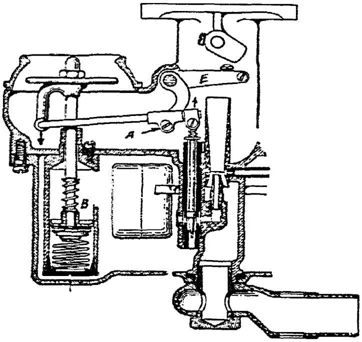


Fig. 127. Schebler Auxiliary Air-Valve Action

A study of the several illustrations will show that the amount of gasoline flowing through the main jet is controlled by the position of the gasoline needle, that is, the gasoline needle is raised or lowered as the air valve is lowered or raised. The further the needle is raised from its seat, the more the gasoline which may pass. In the case of average speeds on good roads the throttle is seldom full open, consequently the auxiliary air valve will not be at its greatest opening. The carburetor has been designed to provide good power and good fuel economy at average driving speeds. However, in the case of driving at top speed or driving when the last bit of power available is to be developed in any kind of going, then it is essential to enrich the mixture for that particular type of work. Under these conditions of wide-open throttle, a cam device has been provided on the end of the throttle shaft. This cam is so arranged as to strike an adjustable screw in the arm *E*, Fig. 129. This movement of parts throws *A* in toward the air valve and results in raising the needle valve a further distance from its seat, thus allowing the greater amount of gasoline required for full throttle opening to be provided.

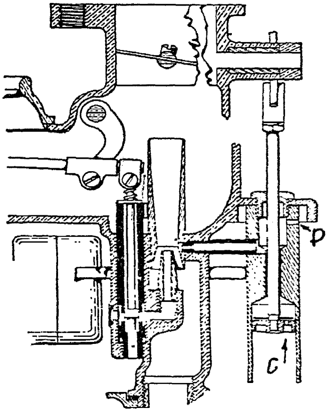


Fig. 128. Accelerating Pump and Well Is Used for Rapid Acceleration under Load

A careful study of this device will show that practically every feature of adjustment required to meet any possible need provides for the gasoline needle being moved up or down. This same method is resorted to for securing a heavy charge of gasoline when starting a cold engine. No air choke is provided in the carburetor. The usual dash-adjusting handle and wire known as the choke button is connected to the arm *E*. This is illustrated in Fig. 130, where it will be noted that *E* is shown in several positions and the connecting wire shows as both a heavy and dotted line, indicated by the arrow. When the dash adjustment is pulled out, the lever is pulled down. This rotates the lever in its shaft *E* in such a manner that *A* is thrown well over toward the air valve and the gasoline needle is raised from its seat, opening up the gasoline passage to its fullest size. Air passing through the fixed opening and the venturi will pick up sufficient gasoline to make starting easy, even with a cold motor. As the engine picks up speed and is warmed up, the dash adjustment should be returned to its normal position. A gradual return of the choker button will keep the engine operating while it is being warmed up.

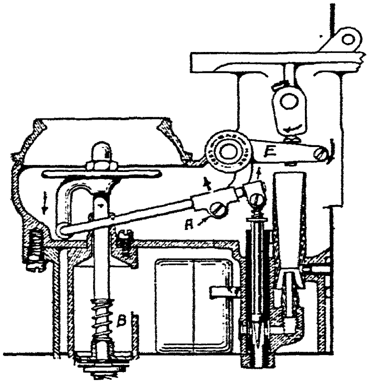


Fig. 129. Wide-Open Throttle Position for Hard Pulling and High Speed

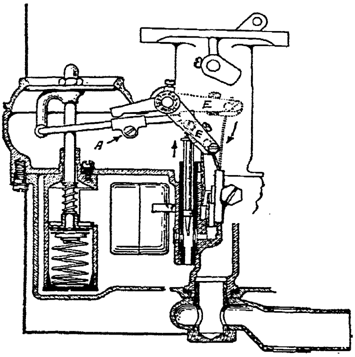


Fig. 130. Raising the Needle for Enriching the Fuel Mixture for Starting a Cold Engine on Schebler Model "S"

Carburetor Adjustments. Having a thorough understanding of the principles involved and the working of the parts shown in the sectional views of this carburetor, the repair man is able to go about the adjustment of the carburetor in an intelligent fashion. A section of the exterior of the carburetor is illustrated in Fig. 131. There are several standard installations of the carburetor with reference to the hook up of the choke wire. The one shown in Fig. 131 is different from the one shown in Fig. 130, but the principles involved are the same.

Idle Adjustment. The idle adjusting screw *A*, Fig. 131, is turned to the right for a lean mixture and to the left for a rich mixture. In order to check the idle adjustment, the motor should be warmed up thoroughly. Close the throttle and retard the spark all the way and then adjust the idle stop screw *B* so that the motor will idle not less than 5 miles per hour on the road. Then proceed to check up. Turn the idle adjusting screw *A* to the right slowly. Watch the motor fan at the same time and continue to turn it in this direction, which is leaning the mixture, until the fan falters or is not turning with a smooth constant motion. Just as soon as the fan is noticed to falter, stop turning the idle adjustment *A* to the right and turn it back or to the left, which is enriching the mixture. If the adjustment is made in the summer, turn the idle adjusting screw backward six notches or clicks. If the adjustment is made in the winter, enrich it eight or nine clicks.

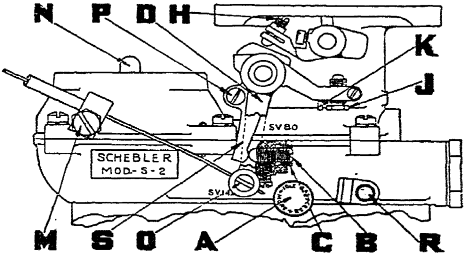


Fig. 131. Service Drawing of Schebler Model "S" Carburetor

Range Adjustment. This refers to the average driving range of speeds between 20 to 40 miles per hour and does not affect the acceleration or hill climbing with wide-open throttle. In order to make this adjustment, turn the range adjusting screw *B* to the left for the lean mixture and to the right for the rich mixture. A road test will show the performance of the car, and the range adjustment should be worked out so as to give a smooth running job between 20 to 40 miles per hour. This will assure good gasoline economy.

Power Adjustment. Extensive laboratory experimentation and road research shows that this carburetor gives the best mixture for maximum power on the hills or at high speeds when the power screw *J*, Fig. 131, is flush with the pin *K*. In high altitudes more power may be obtained by leaning up on the power mixture, that is, turn *J* to the left or counterclockwise from three to five turns. The higher the altitude, the greater the number of turns suggested.

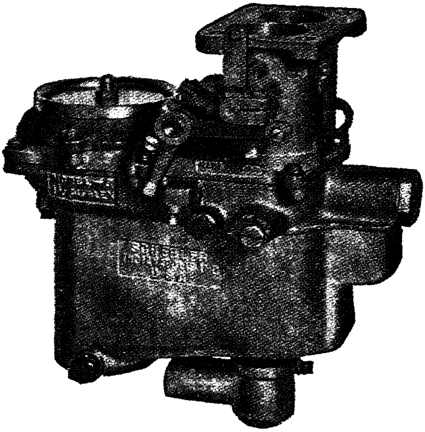


Fig. 132. Schebler Model "S" Duplex Carburetor

Accelerating Pump Adjustment. A small lever has been provided on the accelerating pump. This governs the amount of accelerating action. This lever should be in the raised position for winter, giving a greater amount of extra gas for acceleration. In the summer this lever should be pushed down because in summer not so much gasoline is required for quick acceleration.

Model "S" Duplex Carburetor. The general principles of design used for the single Model "S" are applicable to the duplex Model "S," Fig. 132. When starting a car equipped with this carburetor, the dash control is pulled all the way out. Next turn on the ignition switch, release the clutch, open the hand throttle about halfway, and step on the starting switch button. After the motor starts to fire the dash control is immediately moved about half way back, or to a position where the engine will run smoothly and the car operate satisfactorily. As the engine is warmed up, the dash control is moved further in, in a gradual manner, until it is fully in. It is not necessary to use the dash control when starting a hot engine. If the engine should be flooded, open the throttle half way when cranking.

Carburetor Adjustments. *Idle Adjustment.* The duplex Model "S" is provided with two idle adjustments, shown at *A* and *E* in Fig. 133. Have the engine warm before making any adjustments. Both adjustments *A* and *E* turn to the right in order to make the mixture lean and to the left or counterclockwise to enrich the mixture. The duplex carburetor has two throttle openings into the manifold or two carburetor barrels. The throttle opening and idle adjustment next to the engine always control the four center cylinders of a straight eight—namely, cylinders 3-4-5-6. The throttle opening and idle adjustment of the carburetor which are on its outside or next to the hood of the car always govern the two front and two back cylinders—namely, 1-2-7-8. In order to effect the inside idle adjustment or the one next to the engine, disconnect the spark plug wires from cylinders 1-2-7-8, grounding them some place on the engine head so that they lie in contact with the cylinder head metal. This leaves the four center cylinders 3-4-5-6 operating. These are the ones supplied with gas from the inside barrel of the carburetor and the adjustment with the inside idle screw may proceed.

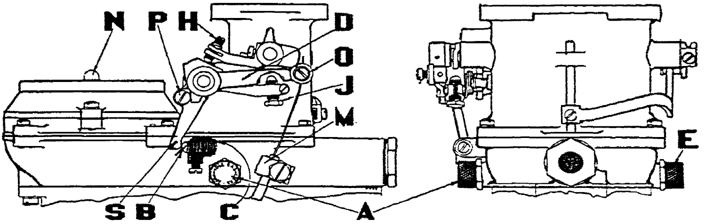


Fig. 133. Service Drawing of Schebler Model "S" Duplex Carburetor

First run the idle adjustment screw *H* in a little ways in order to get a slightly faster idle speed. This is necessary when checking four cylinders at a time. Retard the spark and depress the air valve of the carburetor $\frac{1}{32}$ to $\frac{1}{16}$ inch. If the adjustment is lean on the four center cylinders, the engine will die immediately. If the adjustment is too rich, the engine will speed up. When the adjustment is just right, you should be able to depress the air valve $\frac{1}{32}$ to $\frac{1}{16}$ inch and the engine should continue to turn over for two or three revolutions and after that start to quit running.

When taking an outside idler adjustment, first remove the wires from the four cylinders 3-4-5-6, grounding them and then reinserting the wires on 1-2-7-8. The check-up proceeds just the same as for the four center cylinders.

When the two idle adjustments have been checked up satisfactorily, then the spark-plug wires are connected and a double check-up given by depressing the air valve of the carburetor the same as when checking four cylinders at a time. Before making the final check-up with all eight cylinders firing, the engine idling speed should be checked by setting the idle stop screw *H* so that the engine will drive the car from 5 to 6 miles per hour on the road. When making the final check by depressing the air valve, it may be found that the engine is a little too rich or a little too lean with the eight cylinders all firing. When attempting to correct this, turn the idle adjusting screws exactly the same amount in each case and turn them in the same direction so as to maintain comparative operation. Turn them but one, two, or three clicks at a time and test by depressing the air valve until proper operation is secured.

Range Adjustment. This adjustment is made by turning the range adjusting screw *B* to the left for a lean mixture or to the right for a rich mixture and will affect the driving range of the car between speeds of 20 to 40 miles per hour. The factory setting for this screw *B* is to have the head flush with the bushing *C*. If the range adjustment is changed, it will be found necessary to readjust the idle mixture.

Power Adjustment. This carburetor gives the best mixture for speed and maximum power on hills when the bottom of the head of the power screw *J* is setting so that it measures $\frac{7}{32}$ inch to the arm that holds screw *J*. The original factory setting is to have the bottom of the head on the screw *J* flush with the bottom of the pin. In high altitudes it is always necessary to lean up the mixture in order to secure the best power. In this case, turning screw *J* to the left or counterclockwise from three to five turns is recommended. Turning this same screw to the right enriches the power mixture.

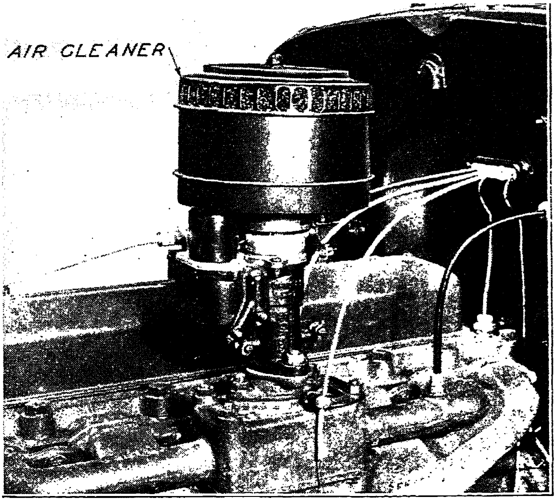


Fig. 134. Chevrolet Down-Draft Carburetor Mounted on Engine

CHEVROLET "SIX" DOWN-DRAFT CARBURETOR 1933 MODEL

A new Chevrolet carburetor, Fig. 134, is of the down-draft type, and before satisfactory adjustment can be made, there are certain steps which must be taken in the adjustment of every unit on the engine. Spark plug gaps should be correctly set, breaker points should be correctly adjusted, the ignition timing should be set according to manufacturers' instructions, and all valve clearances should be adjusted according to manufacturers' specifications.

The units on the engine having been taken care of, the adjustment of the carburetor can be proceeded with, providing that there are no air leaks, and it is suggested that leaky intake manifold flange gaskets should be replaced with new ones and manifold bolts should be tightened.

The carburetor has but a single fuel-supply adjustment—to regulate the idle. First, set throttle lever adjusting screw so that motor runs approximately 350 revolutions per minute with spark fully retarded. Then set idle adjustment screw so that motor fires evenly without "loping" or stalling. The correct setting is one-half to one full turn open. Turning screw out gives a leaner mixture.

If a good idle cannot be obtained by these adjustments, remove low speed jet tube and clean thoroughly with compressed air. Examine soldered joint in tube for leaks and see that tube seats air-tight in body casting, top and bottom. If not, replace with a new tube of identical specification. Never change a low speed jet tube from one carburetor to another.

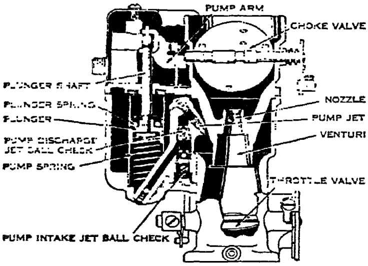


Fig. 135. Sectional View of Chevrolet Down-Draft Carburetor from Side

A correct idle is impossible unless spark plugs and tappets are set accurately as specified.

The accelerating pump, Fig. 135, is very efficient and gives maximum acceleration on about one-half of the quantity of fuel used by the common carburetor accelerating well. When the throttle is opened, it discharges a spray of fuel against the secondary venturi, insuring instant acceleration.

The pump arm is provided with three holes for the connector link, giving short, medium, and long strokes. The medium stroke is correct for ordinary temperatures and standard gasoline. The short stroke should be used in extremely hot climates, high altitudes, or with high test fuel. The long stroke is for use in extremely cold climates.

It is important that the countershaft that operates the accelerating pump be lubricated at least once every 5,000 miles. To lubricate this shaft, remove screw attaching dust cover and fill threaded hole with a good grade of graphite grease.

Increased resistance on foot throttle indicates a clogged pump jet. Pump jet and ball check strainer should be removed and cleaned with compressed air, which, in many cases, will remove the dirt or lint. All jets and ball checks must be seated gasoline-tight.

Poor acceleration may be due to loose plunger, worn or damaged plunger leather, or sediment in pump cylinder. If necessary to replace plunger spring or leather, make certain that the nut inside the plunger cup is screwed down tight to avoid air leaks. Always use loading tool when replacing plunger in cylinder to avoid damage to leather.

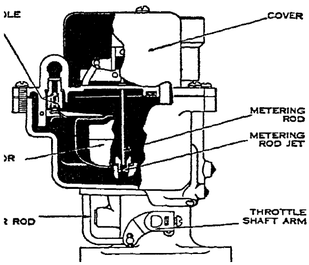


Fig. 136. Sectional View of Chevrolet Down-Draft Carburetor from Front

If the carburetor loads up after considerable service, the float level should be checked. The float level should be $\frac{3}{8}$ inch, as shown in Fig. 136. Wear on lip of float lever will, in time, raise the float level.

To check the float level, remove dust cover. Disconnect metering rod, throttle connector rod, and plunger shaft. Take off float chamber cover and remove cork pump gasket from cover. Place steel scale on metal rim which holds pump gasket. Measure to nearest point of float.

To reset float, bend lip of float lever. A very slight bending is sufficient to change float level. Be sure lugs on float lever permit float to drop at least one-half inch from $\frac{3}{8}$-inch level, or to a point $\frac{7}{8}$ inch from float chamber cover. When replacing float chamber cover, be sure gasket seats air-tight against body.

In fuel-air ratio, each carburetor is calibrated to provide maximum power and mileage on standard gasoline in normal altitudes, and flow-tested to determine accurately the volume of air and fuel comprising the mixture. Leaner than standard fuel mixtures are obtainable by the use of special metering rods, as listed.

Great care must be used in changing metering rods, Fig. 136. Remove dust cover, take off pin spring, and turn rod one quarter turn counterclockwise to disengage it from pump arm. Be careful not to lose disc on rod. Insert new rod (with disc in place), holding it vertical to insure rod entering jet in float chamber. With throttle closed, turn rod one quarter turn to engage pin on pump arm. If lower end of rod is in place in jet, rod will engage pin on pump arm readily and hang vertical from pin. Any difficulty in re-assembling will indicate rod has not entered jet, in which case carburetor will not function. Replace pin spring and dust cover. Be sure lock washer is under head of attaching screw.

For years the carburetors for the Chevrolet models have been made by the Carter Carburetor Company. In every case these carburetors are calibrated, with reference to jet size, for the particular model engine to which they are fitted. While it is true that in the main the Chevrolet carburetors are similar, they are not interchangeable. It is difficult for the average mechanic to grasp the difference in car performance which is secured by changing jets. A minor difference in jet size will make major changes in performance and gasoline consumption economy. The mechanic who understands these points will use care when repairing carburetors.

Model "RJHO8." The International Chevrolet is equipped with a Model "RJHO8" multiple-jet plain-tube Carter carburetor of special design in which have been incorporated the improvements in the art of carburetion. Two views of this carburetor are shown in Fig. 137 with a list of the part names.

The conical type venturi choke insures excellent starting in cold weather and even firing during the warming-up period. This is ac-

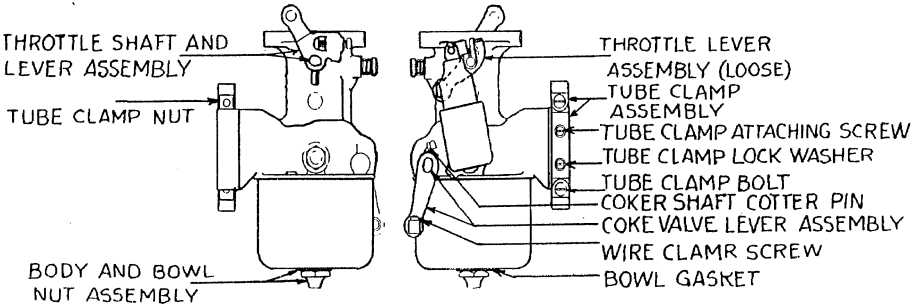

THROTTLE SHAFT AND LEVER ASSEMBLY
TUBE CLAMP NUT
BODY AND BOWL NUT ASSEMBLY
THROTTLE LEVER ASSEMBLY (LOOSE)
TUBE CLAMP ASSEMBLY
TUBE CLAMP ATTACHING SCREW
TUBE CLAMP LOCK WASHER
TUBE CLAMP BOLT
COKER SHAFT COTTER PIN
COKE VALVE LEVER ASSEMBLY
WIRE CLAMR SCREW
BOWL GASKET

Fig. 137. External Construction and Adjustments of Chevrolet "Six" Carter Carburetor

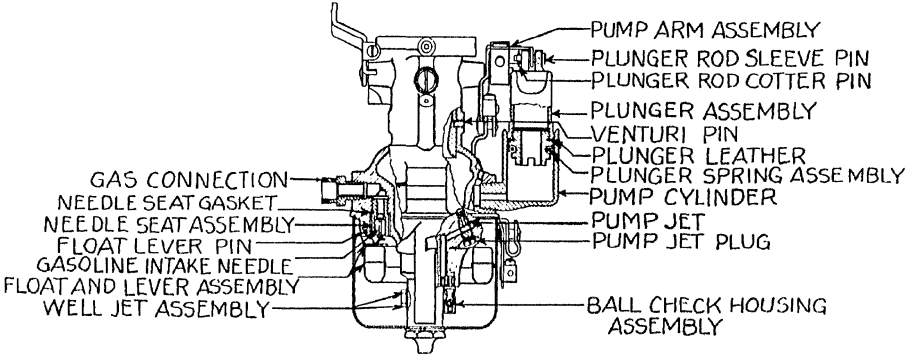


Fig. 138. Section through Float Chamber of the Chevrolet "Six" Carter

complished by regulating the main air opening at the venturi throat instead of at the carburetor air intake, as on the former models. By regulating the amount of air entering the venturi, the mixture ratio may be varied anywhere from 14 to 1 to 4 to 1 as desired, and due to the double-venturi construction, fuel is always thoroughly atomized as it leaves the standpipe and enters the mixing chamber.

Starting the Engine. When starting, the button on the instrument board marked "C" which operates the choke should be pulled out as far as possible. The button marked "G" which controls the throttle position should be pulled out slightly. When the engine starts, push the choker button in slowly a very short distance. The choker is not effective to any great extent in keeping a cold engine running unless the button is pulled nearly all the way out. If the engine runs at an excessive rate after starting, the throttle button "G" should be pushed in slightly till the proper speed is attained. If the engine gallops, the choke button should be pushed in slowly till the engine runs smoothly. As soon as the engine warms up enough to operate with the choke fully opened, it should be set in that position and at that time the throttle may be closed to idling position. During the warming-up period, it is recommended that the throttle valve be kept open to a point that will give an idle on level ground of from 12 to 15 miles per hour. This is the best position for starting the motor whether hot or cold and whether choke is used or not.

In extremely cold weather it is advisable, before pulling the choker, to depress the foot accelerator pedal three or four times, allowing the pedal to remain in the down position from one to two seconds each time it is depressed. This will operate the accelerating pump and spray gasoline into the intake manifold. Then set the dash throttle button to the correct position for starting and close the choke fully. When this procedure has been followed, very quick starting will be obtained, even in unusually cold weather. **Do not pump the throttle for starting when the engine is hot.**

Accelerating Pump. A specially designed accelerating pump, Fig. 138, providing long delayed action has been incorporated to aid in securing maximum acceleration and car performance. This pump is equipped with a ball-check inlet valve in the float chamber and a No. 75 jet, which discharges through the air chamber into the venturi and will deliver a spray of gasoline for about two seconds after the throttle has been opened.

To secure high mileage, a fuel metering rod has been attached to the throttle valve which regulates the size of the vertical jet. This gives the equivalent of a small vertical jet for part throttle running, which insures the greatest economy at regular driving speeds, and a large vertical jet when the throttle is wide open, which gives maximum power for both speed and hill climbing. The mixture may be varied for different climates and fuels by changing the well jet which is located in the base of the body. Standard well jet is No. 57; richer jet is No. 56½; leaner jets are Nos. 58, 59, and 60. These jets may be used wherever a change in the mixture ratio is deemed necessary.

Acceleration of this carburetor is dependent to a great extent on the action of the pump and it is advisable to oil the plunger leather in the pump with a suitable oil whenever the car will be standing idle for any length of time. It is also necessary that the ball check seat properly, as any leak at this point will cause a loss of efficiency. If the pump jet becomes plugged up, the throttle will be hard to operate; in which case the pump jet should be removed and cleaned.

The carburetor is equipped with one adjustment only which is to regulate idling and low-speed mixture. This is an idle adjustment, Fig. 139, located opposite the edge of the throttle valve. Turning the adjustment screw in reduces the amount of air entering the carburetor at this point and gives a richer idling mixture. Turning it out gives a leaner mixture. The correct adjustment is from ⅝ to 1¼ turns out. In securing a good idle on the Chevrolet "Six" engine, it is necessary to have the valves properly adjusted to a clearance of .008 inch on the exhaust and at least .006 inch on the intake, when the engine is thoroughly hot. Starting an engine and just warming it up does not get the engine hot enough to insure the proper valve clearance. If, after a hard drive, the engine does not idle smoothly, the valve clearance should be checked at that time and correct setting made. This will insure proper seating of valves at all times and will greatly increase the efficiency and life of the engine.

Carburetor Operation. The low-speed jet assembly, Fig. 139, supplies gasoline to the engine at idle engine speed and up to approximately 20 miles per hour, gasoline flowing through a drilled passage

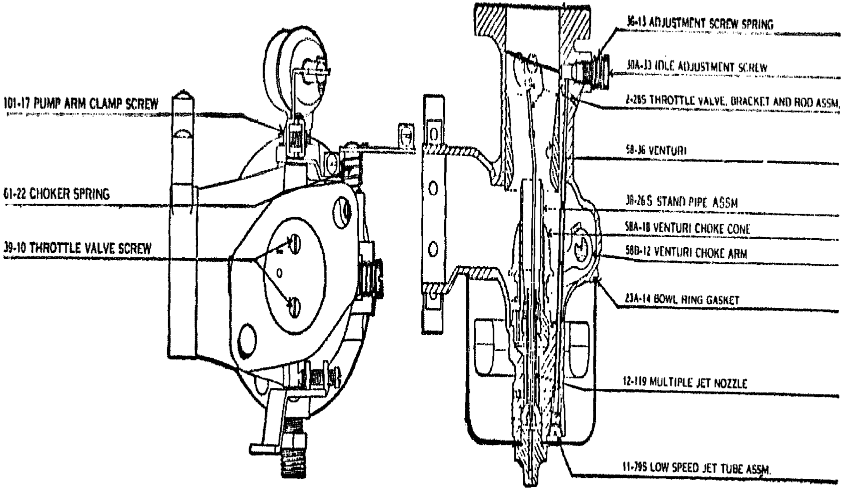

101-17 PUMP ARM CLAMP SCREW
61-22 CHOKER SPRING
39-10 THROTTLE VALVE SCREW
36-13 ADJUSTMENT SCREW SPRING
30A-33 IDLE ADJUSTMENT SCREW
2-285 THROTTLE VALVE, BRACKET AND ROD ASSM.
58-36 VENTURI
38-26 S STAND PIPE ASSM
58A-18 VENTURI CHOKE CONE
58B-12 VENTURI CHOKE ARM
23A-14 BOWL RING GASKET
12-119 MULTIPLE JET NOZZLE
11-79S LOW SPEED JET TUBE ASSM.

Fig. 139. Top View and Section through Venturi of the Chevrolet "Six" Carter

connecting the low-speed jet chamber with the carburetor well. At idle speed, gasoline is drawn through the low-speed jet and the idling port at the edge of the throttle valve. The idle adjustment screw regulates the amount of air entering this port. Backing out the adjusting screw admits more air and consequently makes the idling mixture leaner.

The vertical jet in the base of the multiple jet nozzle feeds gasoline direct to the nozzle chamber. The well jet in the side of the body feeds gasoline to the carburetor well. From this well a combination of gasoline and air is drawn into the nozzle chamber through the accelerating jets on the side of the nozzle, which intermingles with the fuel from the vertical jet, the combination forming a fine spray which is carried by the standpipe to the venturi or main air passage where it is absorbed by the incoming air, forming a mixture on which the engine operates. The jets on the side of the nozzle come into operation in direct proportion to the throttle position. The further the throttle is opened, the more jets are in operation. At wide-open throttle, all the jets are working and the engine is getting the maximum supply.

Starting Mixture. The starting mixture has been as carefully calibrated as the standard running mixture and when the engine is cranked over, the correct proportion of air commingles with a spray of fuel, forming a perfect starting mixture. Due to this design, which regulates the size of the main venturi air passage, the danger of over-choking the engine and of crank-case dilution is reduced to a minimum. While warming up the engine, set the choke to the position where the engine runs best, pushing it in to regular running position when the engine is thoroughly warm.

Accelerating Pump. The accelerating pump consists of an air chamber and fuel container which has been added to the accelerating well. The pump is actuated by the throttle lever, Fig. 137. When the throttle valve is closed, the gasoline is drawn into the pump cylinder through the ball-check housing assembly. The ball-check automatically closes when the throttle is opened, air is compressed in the plunger, and a fine spray of gasoline is discharged into the venturi through the pump jet. About two seconds is required to discharge the contents of the pump, supplying sufficient gas for accelerating under any and all conditions.

Leaks in the pump connections or dirt in the pump jet or ball check will interfere with its action. If the pump leather becomes dried out, put a few drops of castor oil on it. If the plunger is removed from the cylinder, a special tube must be used for reassembling, otherwise the leather will be damaged.

To start the engine, turn on the switch, pull the choker button out, pull the throttle button out slightly, and press the starter pedal. In extremely cold weather the engine should be allowed to run a few seconds with the choker in fully choked position. It should then be pushed in part way until the proper running mixture is secured.

Be sure the wire connecting the choker button on the dash and choker lever is adjusted properly so the choke will be wide open when the button is pushed in. This is normal running position.

The carburetor is calibrated to give the greatest efficiency when the engine is hot. Do not expect a cold engine to run properly with the choker pushed in. It will be found necessary to run the car, partly choked, longer in winter than in summer. The radiator should be partially covered to obtain the maximum efficiency in cold weather.

Carburetor Adjustment. The adjustment is properly set when the car leaves the factory and should not be changed until the engine is thoroughly run in. If necessary, the carburetor may then be readjusted. To adjust the idling mixture, retard the spark—open idle adjustment screw, Fig. 139, five-eighths to one and one-quarter turns or until the engine hits evenly without loading or missing. Turning this screw in gives a richer mixture.

The idle engine speed is regulated by the throttle lever adjusting screw. This acts as a stop for the throttle lever and prevents the throttle valve from closing too tight and allowing the engine to stop when the accelerator is released. With the throttle on the instrument board closed, set the throttle-lever adjusting screw so the engine will run 300 revolutions per minute. If the engine runs too fast, back the adjusting screw out; if too slow, turn in until the proper speed is obtained. The throttle adjusting screw is locked in the throttle lever by tension on the lugs through which the screw passes. If the screw becomes loose, these lugs should be bent slightly until the proper tension is again obtained.

Operation of Float. Gasoline, after passing through the needle seat, is admitted to the carburetor bowl by the gasoline intake needle and float. This mechanism maintains the correct level of fuel in the bowl. The float is properly set at the factory and should not be changed. The correct level is three-quarters inch from the top of the float to the machined surface of casting when the needle is closed, Fig. 140. This measurement should be taken on the side of the float opposite the gasoline intake needle. If, for any reason, the float lever must be reset, it may be done by bending the float-lever lip that comes in contact with the gasoline intake needle. Bending the lip up will lower the float level and bending it down will raise it. Only a slight bend is necessary to change the level.

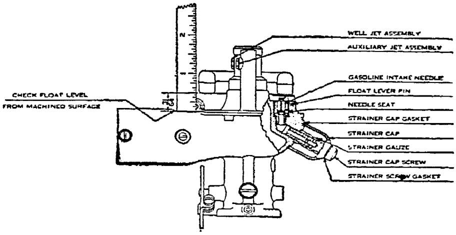


Fig. 140. Checking Float Level

Flooding. Flooding may be caused by dirt lodging between the needle and needle seat and can often be remedied by tapping the gasoline connection, the jar dislodging the dirt and allowing the needle to seat. If necessary to remove the needle and seat, it may be done by removing the bowl and float. Be careful in taking out the needle not to drop it, as it has a polished point which a scratch or dent would ruin. Wipe off the needle and wash the seat in gasoline. The needle may then be reseated, if necessary, by rotating it against the needle seat and tapping it lightly in the seat with a wooden handle of a hammer or screwdriver. Use wood so as not to mar the base of the needle which operates against the float lever lip. If the needle seat has to be removed, use a large bladed screwdriver and be sure to remove any burr that might be thrown up at the screwdriver slot as this might interfere with the proper action of the needle. In reassembling, be sure the gasket is not torn, then tighten the needle seat securely in place. In replacing, be sure all the parts are properly assembled—pointed end of needle in seat and rounded end projecting—and that all joints in the gasoline line are tight. Leaks in the gas line are both dangerous and expensive.

Flooding may also result from the float touching the bowl. This is caused either by the bowl being improperly seated at the top or by the float lever, Fig. 138, having been bent. If the float is rubbing, a bright spot will be found at the point of contact. This may be corrected by setting the float at its proper level or seating the bowl on the gasket in the carburetor body. If the float lever has been badly bent, a new float is the quickest and best remedy.

A float that has been punctured will cause the carburetor to flood. If the float is leaking, it will be evident from its weight and from the gasoline inside of it. In case of a leaking float, replacement with a new one is the only practical course. Soldering floats is rarely successful and often dangerous. The float and lever are soldered in a jig which insures a proper position when assembled in the carburetor at the factory. Be sure to set the float level properly when installing a new float.

Model "RTO8=13OS." The Carter carburetor used on the Chrysler Plymouth car is very similar to those used on some of the other cars in the same price class. The description given here will be helpful in such cases as well as for the direct application to the Plymouth job.

The Carter carburetor, Fig. 141, for the Chrysler Plymouth has been designed so as to give quick starting in any kind of weather and to insure steady running after starting, even with the engine cold. It is likewise designed to give efficiency as well as maximum speed and power on open throttle. Maximum economy of the carburetor is secured at approximately 20 miles per hour and the poorest economy is secured on wide-open throttle. The starting mixture is controlled by a single button on the instrument board. When this button is pulled out, the air passages are automatically closed through the venturi and the throttle is opened to correct position for starting. Air is then metered into the carburetor well and standpipe where it mingles with the gasoline and forms a spray of atomized fuel which is then drawn into the cylinders and readily ignited.

The interconnections between the choker and throttle levers automatically increase the engine idling speed to approximately 15 miles per hour during the period when the carburetor is partially choked. Naturally this advance in speed results in an engine which will keep running even though it is cold, thus eliminating the necessity of racing the cold engine before the oil in the crank case has had sufficient time to warm up and flow freely. An accelerating pump is used which consists of an air chamber and fuel container. The accelerating pump is actuated by means of a throttle lever. Only one adjustment is provided. This is for idling speed.

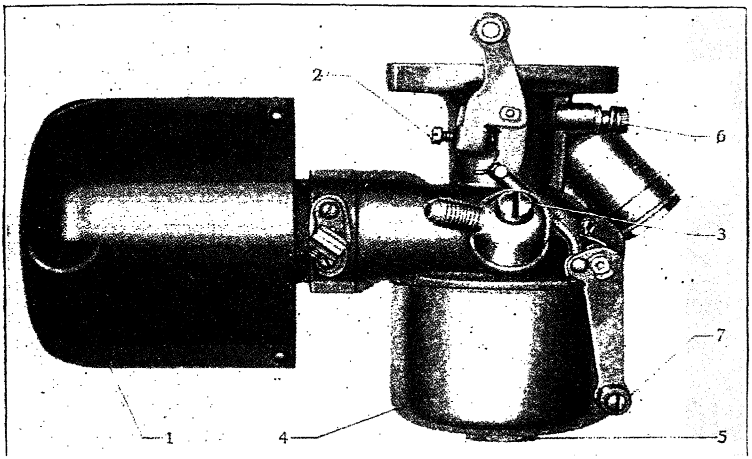


Fig. 141. Carter Carburetor and Air Cleaner

Carburetor Operation. The low-speed jet assembly supplies gasoline to the engine at the idling speed and up to approximately 18 miles per hour. Gasoline flows through a drilled passage, connecting the low-speed jet chamber with the carburetor well. At idle speed gasoline is drawn through the low-speed jet and the idling port at the edge of the throttle valve. The idling adjustment screw regulates the amount of air entering this port. Backing out the adjusting screw admits more air and makes the idling mixture leaner.

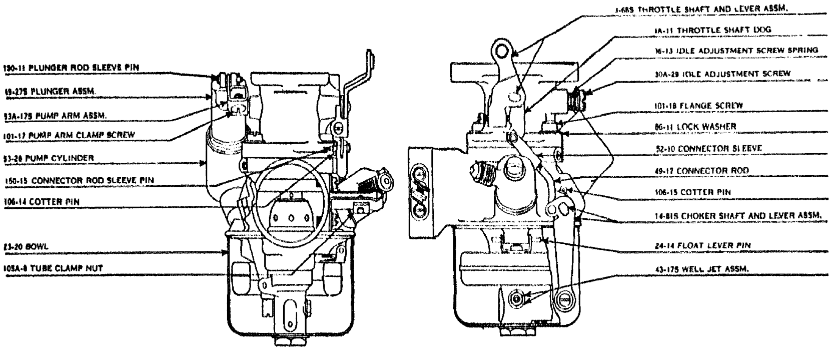


Fig. 142. Front and Side View of Chrysler-Plymouth Carburetor with Names of Parts

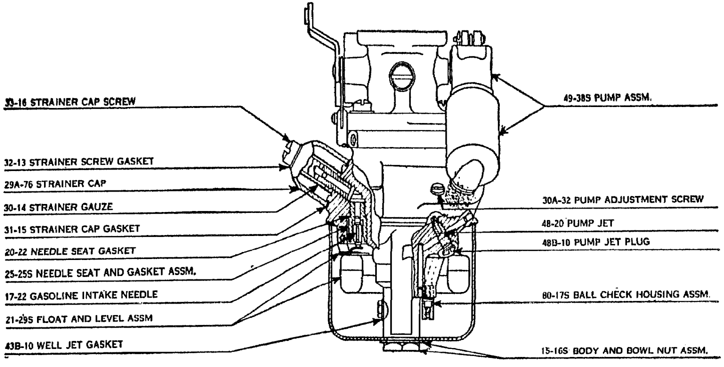

33-16 STRAINER CAP SCREW
32-13 STRAINER SCREW GASKET
29A-76 STRAINER CAP
30-14 STRAINER GAUZE
31-15 STRAINER CAP GASKET
20-22 NEEDLE SEAT GASKET
25-25S NEEDLE SEAT AND GASKET ASSM.
17-22 GASOLINE INTAKE NEEDLE
21-29S FLOAT AND LEVEL ASSM
43B-10 WELL JET GASKET
49-38S PUMP ASSM.
30A-32 PUMP ADJUSTMENT SCREW
48-20 PUMP JET
48B-10 PUMP JET PLUG
80-17S BALL CHECK HOUSING ASSM.
15-16S BODY AND BOWL NUT ASSM.

Fig. 143. Part Section View of Plymouth Carburetor

A vertical jet in the base of the multiple-jet nozzle feeds the gasoline direct to the nozzle chamber. The well jet in the side of the carburetor body supplies gasoline to the carburetor well. From this well a combination of gasoline and air is drawn into the nozzle chamber through the accelerating jets on the side of the nozzle, which intermingles with the gasoline from the vertical jet, thus forming a very fine spray which is carried by the standpipe to the venturi or main air passage where it is absorbed by the incoming air, forming a fuel mixture on which the engine operates efficiently. The jets on the side of the nozzle come into operation in direct proportion to the throttle opening. The further the throttle is opened, the more jets are in operation, thus metering the gasoline in proportion to the air. At wide open throttle, all the jets are working and the engine is getting a maximum fuel supply.

Carburetor Adjustments. *Choke.* The choke is hooked up in connection with the throttle lever, Fig. 142, so that when the engine is choked, the throttle is opening slightly. When warming up the engine, set the choke to a position where the engine runs best, pushing it in to regular running position as rapidly as the engine warms up. The action of choking the engine automatically increases the engine speed enough to prevent it stopping or stalling in traffic. If the driver is in the habit of pushing the choke all the way in as soon as the engine starts, it is likely the engine will stall in traffic when the engine is cold, with the result that the benefits of the design are lost to him. The choke is operated by the small button or knob on the instrument board.

Accelerating Pump. When the throttle valve is closed, the cylinder of the gasoline pump, Fig. 143, is filled with gasoline through a ball check in the housing assembly. This ball check automatically closes when the throttle is opened, air is compressed in the plunger, and a fine spray of gasoline is forced through the pump jet into the venturi tube. This gives what is termed a delayed action. Several seconds are required to discharge the contents of the pump, thus supplying sufficient gasoline for the accelerating period.

Air leaks in the pump connections or dirt in the pump jet or ball check naturally interfere with the accelerating action. If the pump leather becomes dried out, it should be treated with a few drops of castor oil. If the plunger is removed from the cylinder for

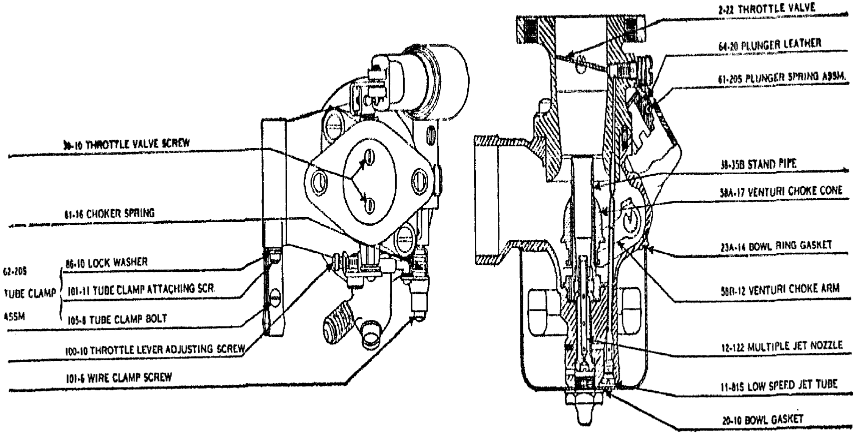


Fig. 144. Top View (left) and Sectional View (right) of Chrysler-Plymouth Carburetor

repairs, it will be necessary to use a special tube for reassembling it otherwise the leather may be damaged.

Idle Adjustment. It is never recommended that a carburetor be adjusted until the new car has been completely run in. If the car has been run in and operation is not satisfactory, the carburetor setting may be changed.

In order to adjust the idling mixture, the idling adjustment screw, Fig. 142, should be opened from one to one and five-eighths turns or until the engine hits evenly without loading or missing. Turning this screw in gives a richer mixture and turning it out gives a leaner mixture.

The pump adjustment screw, Fig. 143, is located in the body of the casting at the base of the pump cylinder and regulates the amount of gasoline sprayed into the venturi when the throttle is opened. Turning this screw in increases the amount of gasoline discharged through the pump jet.

The idle engine speed is regulated by the throttle-lever adjusting screw, Fig. 144. This acts as a positive stop for the throttle lever and prevents the throttle valve from closing too tight and allowing the engine to stop whenever the foot accelerator is released. When adjusting this screw, the first step is to set the hand throttle lever so as to secure an engine speed of approximately 300 revolutions per minute. If the engine runs too fast, it will be necessary to back out the adjusting screw. Make certain that the screw is locked in the lugs. If the screw becomes loose in the lug, it should be taken out and the lugs bent in slightly. When the screw is replaced it will be under sufficient tension to hold it.

Float Level Adjustment. The correct float level is $\frac{11}{16}$ inch from the top of the float to the machined surface of the casting when the needle is closed, Fig. 145. When resetting the float level, if this should be necessary, the work is done by bending the float lever lip which comes in contact with the gasoline intake needle. Bending the lip up will lower the float level and bending it down raises the gasoline level. Only a very slight bend is necessary.

Flooding may be caused by dirt lodging between the needle and the needle seat. The dirt can often be removed by tapping the strainer cap screw. The jar thus secured will allow the needle valve to seat. If the flooding is continuous, it will be necessary to remove the intake needle. To do this remove the bowl and float. Carefully remove the needle, protecting the point, as it is easily damaged by dropping or scratching. Wipe off the needle and wash out the needle valve seat with gasoline. If it is found necessary to reseat the needle, turn it lightly in the seat, tapping it lightly with a wooden mallet or the wooden handle of a hammer or screwdriver. Use wood so as not to mar the base of the needle which rotates against the float lever lip. In case it is necessary to remove the needle valve seat, use a large wide-bladed screwdriver and then be very certain to remove any burr which may turn up at the screwdriver slot. When reassembling, be sure the gasket is smooth and in place, then tighten the needle valve seat securely in position.

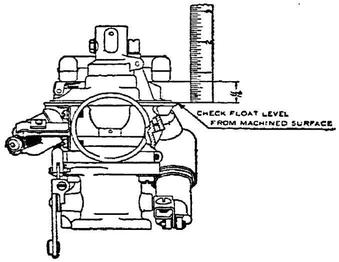


Fig. 145. Checking and Adjusting Chrysler-Plymouth Float Level

When replacing the parts, use utmost care to see that they are not damaged and that they go back in their original position.

Check all gasoline tubing connections and fuel pump connections to see that leaks are not occurring at these points. In some cases, flooding results from the float touching the bowl of the carburetor. This might be the case if the bowl were improperly seated at the top or if the float lever had been bent. When inspecting the float, if a bright spot shows, it will indicate that there is some point of contact. Correct this by seating the float at its proper level or by seating the bowl on the gasket in the carburetor body. If the float has been badly bent, a new float is the best remedy. Flooding may be due to a punctured needle. If the float is leaking, it will be evident from its weight and from the sound of gasoline in it when shaken near the ear. In case of a faulty float, the only satisfactory repair is to replace it with a new one.

Cleaning the Carburetor. The most usual point requiring cleaning is the point at which the gasoline enters the carburetor through a fine wire gauze strainer which is located in the strainer cap. While this strainer will prevent the coarser particles of dirt from entering the carburetor, some of the very fine dirt, which may be dissolved, will be carried through it. The strainer should be cleaned each 2,000 miles. When doing this, remove the gasoline line, unscrew the strainer cap screw, and lift the strainer cap. Next remove the screen gauze and thoroughly clean it by washing it in gasoline and using an air jet to blow through it. Next clean the inside of the strainer cap thoroughly and reassemble, making certain that all parts are in their proper positions, neat and tight.

Dirt may sometimes get into the jets and cause the engine to operate unevenly or spit and backfire, indicating a lean mixture. If the operation of the engine indicates trouble of this sort, it is oftentimes possible to draw this dirt on through the jets if the car is taken on the street and operated at a speed of 25 to 30 miles per hour. When operating at this speed, hold the choker closed for about two seconds with the accelerator pushed to the floor board, which gives a wide-open throttle position. The momentum of the car, in gear, will carry the engine along until the operation has been completed. After the choker has been held closed for several seconds, it should be opened and the repair man should jiggle the accelerator, thus opening and closing the throttle. In a few more seconds the engine should begin to operate evenly. This operation will require but a few minutes to try. If it does not result in clearing out the obstruction within the carburetor, it will be necessary to remove the carburetor and disassemble. When disassembling the carburetor, utmost care is necessary when removing the jets. Make sure that the screwdriver is of the proper size, otherwise the jets, which are screwed in very snugly at the factory, will have their screwdriver slots destroyed and then the job cannot be disassembled or repaired. When cleaning out the jets it must be remembered that they are constructed from brass, which is a comparatively soft metal. If the size of the jet openings is enlarged, the efficiency of the carburetor will be destroyed.

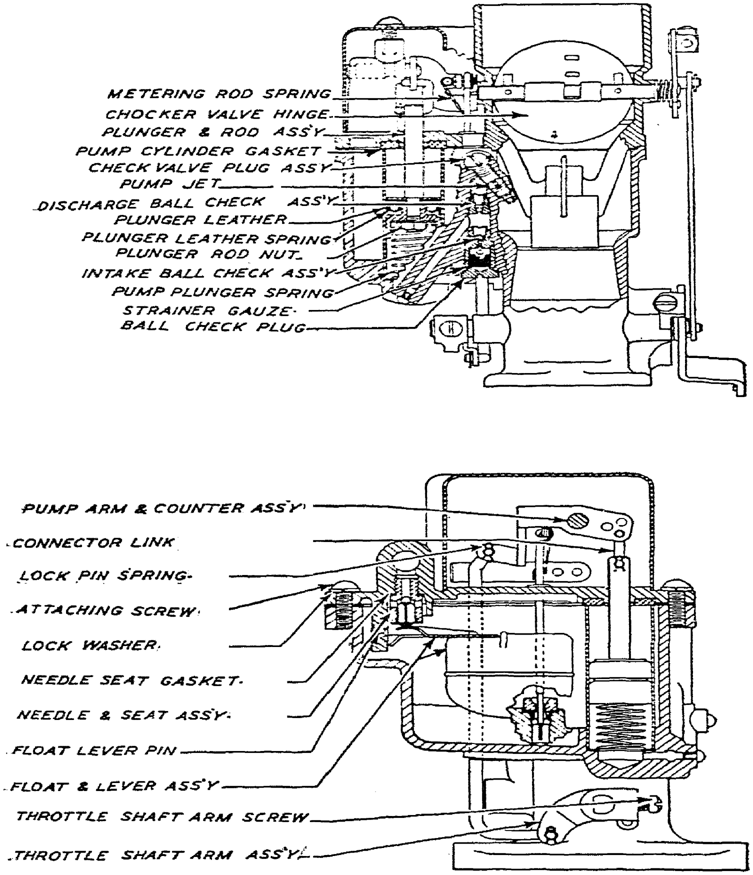


Fig. 146. Pontiac Carburetor in Sectional Views

PONTIAC CARBURETOR

Model "283=S." The Model "283-S" Carter triple venturi downdraft carburetor, Fig. 146, is used on the 1934 Pontiac straight eight. It employs an economizer, metering rod, and a low pressure type accelerating pump with adjustable stroke. The carburetor is only one of the factors which affect performance and fuel economy. Good practice demands that this unit be untouched until after inspection has been made to determine whether trouble exists in some other unit. See that the gasoline lines are clear; that the fuel pump is properly supplying fuel; that there are no leaks at manifolds; that the ignition system is in proper condition; and that there is even compression in all cylinders with tappets correctly adjusted.

Carburetor Adjustment. A single fuel supply adjustment is provided to regulate the idle. First, set the throttle lever adjusting screw so that the engine runs approximately 360 revolutions per minute or 6 miles per hour idle in high gear on level road. Then set idle adjustment screw, Fig. 147, so that the engine fires evenly without loping or stalling. The correct setting is one-half to one full turn open. Turning the screw in gives a leaner mixture, and vice versa.

Accelerating Pump. When the throttle is opened, it discharges a spray of fuel against the secondary venturi, insuring instant acceleration. The pump arm is provided with three holes for the connector link, giving short, medium, and long strokes. Medium stroke is correct for ordinary temperatures and standard gasoline. Short stroke should be used in extremely hot climates, high altitudes, or with high test fuel. The long stroke is for use in extremely cold climates.

It is important that the countershaft operating the accelerating pump be lubricated at least once every 5,000 miles. To lubricate this shaft, remove the screw attaching the dust cover and fill the threaded hole with a good grade of graphite grease. Increased resistance on the foot throttle indicates a clogged pump jet. The pump jet and ball check strainer should be removed and cleaned with compressed air which, in many cases, will remove the dirt or lint. All jets and ball checks must be seated gasoline-tight.

Poor acceleration may be due to loose plunger, worn or damaged plunger leather, or sediment in the pump cylinder. If necessary to replace plunger spring or leather, make certain that the nut inside the plunger cup is screwed down tight to avoid air leaks.

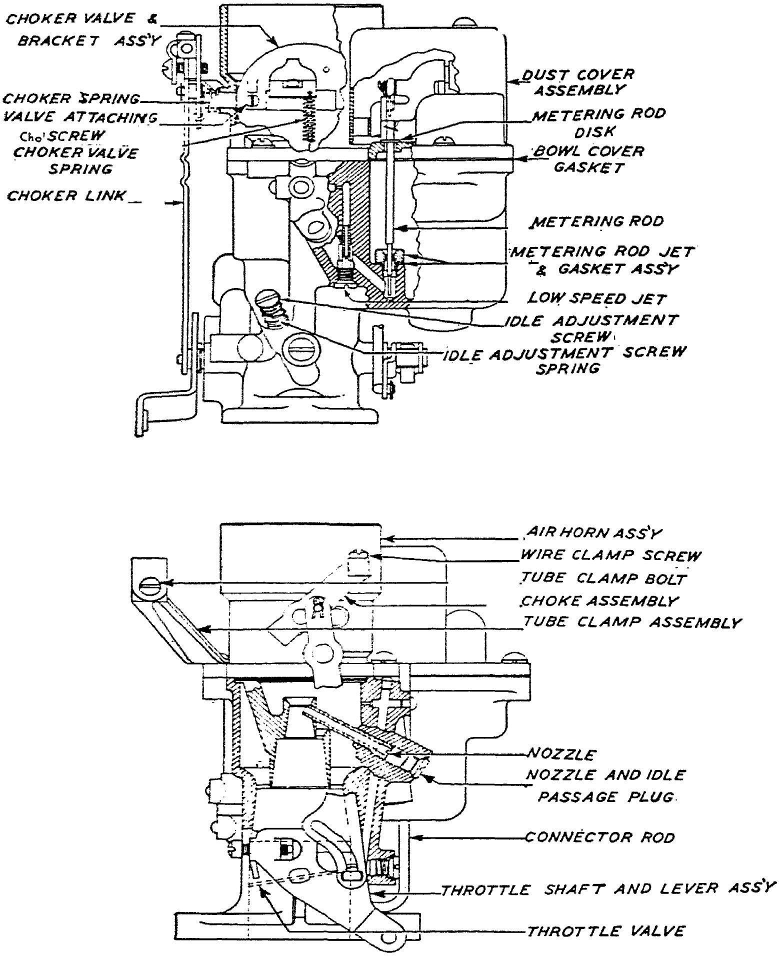


Fig. 147. Pontiac Carburetor in Sectional Views

Float Level. If the carburetor loads up after considerable service, the float level should be checked. Wear on the lip of the float lever will raise the float level. To check the float level, remove the dust cover; disconnect the metering rod, throttle connector rod, and plunger shaft; take off the float chamber cover and remove the cork pump gasket from the cover; place the steel scale on the metal rim which holds the pump gasket and measure to the nearest point of float. This dimension should be $\frac{3}{8}$ inch, as shown in Fig. 148.

To reset the float, bend the lip of the float lever very slightly, which is sufficient to change the float level. Be sure the lugs on the float lever permit the float to drop at least one-half inch from $\frac{3}{8}$ inch level, or to a point $\frac{7}{8}$ inch from the float chamber cover when the float bowl is empty. When replacing the float chamber cover, be sure the gasket seals air-tight against the body.

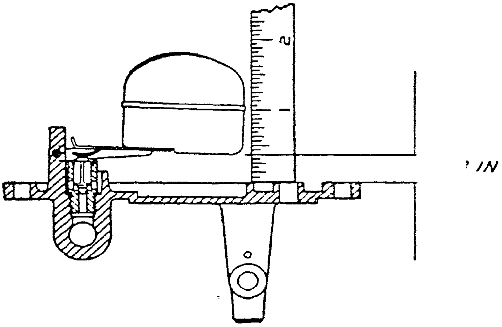


Fig. 148. Adjusting Float Level

Heat Control. Manifolds have been designed to utilize the exhaust gases of the engine to insure complete vaporization and a consequent minimum consumption of fuel. The heat control assembly is fully automatic in its operation, being controlled by a coiled thermostatic spring mounted on the forward side of the heat control section of the exhaust manifold. A counterweight under spring tension is mounted on the rear end of the heat control valve shaft to permit uniform and proper opening and closing of the valve during engine operation. This means that during the warm-up period or initial starting all the possible heat is deflected to and around the intake manifold at the time when it is most required. Due to thermostatic action, as the engine warms up, heat is gradually directed away from the intake manifold by the heat control valve, so that, as high driving speeds are reached, a minimum amount of heat is retained and all exhaust gases are passed direct to the exhaust pipe and muffler.

The heat control valve and path of exhaust gases are shown in Fig. 149. To provide proper operation of the heat control valve at all temperatures, it must be accurately set and it will then require only seasonal adjustments, winter or summer. With the coiled thermostat spring connected to the valve shaft and with the engine cold, the clamp screw must be made tight to prevent slippage of the counterweight lever on the shaft. The screw should be parallel with the flat on the shaft.

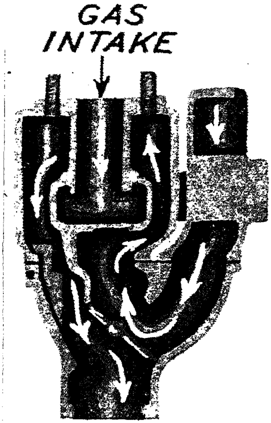


Fig. 149. Heat Control Valve, Sectional View

To make seasonal adjustment, the thermostat cover must be assembled with the ear marked "top" on the upper screw in the exhaust outlet, Fig. 150. The shutter on the thermostat cover must be set so that the blades are in the "open" position in winter and in the "closed" position in summer. The open position permits cold air to blow through the shutter and cool the thermostat in winter. The shutter is not completely closed in the summer position, but should be rotated as far as the stop will allow. For winter use, the thermostat stud should be in the third hole from the left, as viewed from the front of the engine, and for summer use, in the second hole from the left. Four holes in all are provided for the stud, one at either side of the two holes mentioned above. This gives a greater range for extreme temperatures. The warm-up period is prolonged by increasing the tension of the thermostat coil spring and shortened by decreasing the tension.

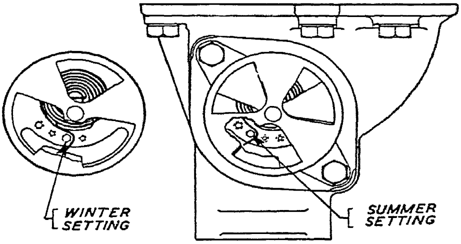


Fig. 150. Seasonal Adjustment

Thermostat cover must be assembled with ear marked "top" on upper screw in exhaust outlet.

Shutter on thermostat cover is to be adjusted "open" in winter and "closed" in summer. Shutter is not completely closed in summer position but should be rotated as far as stop will allow.

The two end holes in the row of four are provided to meet extreme conditions of temperature. If necessary to prolong the warm-up period in extremely cold weather the pin may be placed in the position giving greatest tension to the thermostat, and to decrease the warm-up, set in the position for least tension.

1934 CHEVROLET CARBURETOR

The down-draft carburetor contributes to the smooth, quiet operation and power of the Chevrolet valve-in-head engine. Down draft, as its name implies, eliminates the necessity of lifting air and gasoline from the carburetor, thus improving the breathing ability of the intake system without affecting its flexibility. This carburetor, Fig. 151, embodies a principle which employs three venturis, one located above, and two below the level of the fuel in the float chamber. This triple venturi has the effect of increasing the suction on the first or primary venturi, causing the nozzle to start delivering fuel at very low air speeds. The nozzle enters the primary venturi at an angle, discharging upwardly against the air stream. This angle secures an even flow of correctly proportioned and finely atomized fuel.

The fuel thus atomized in the primary venturi is kept centrally located in the air stream by the surrounding blanket of air passing into the second venturi, and this process is repeated by the air in the main venturi. By this means, the fuel is carried to the cylinders in a more perfectly atomized condition. This insulated atomization results in increased smoothness of operation at both low and high speeds. The mixture quality is controlled by a metering rod which operates within the metering rod jet, Fig. 151, and is operated by the throttle lever. There are two steps of different diameters on this metering rod. The larger diameter, or economy step, controls the fuel flow to about seven-eighths throttle when the smaller diameter, or power step, becomes effective, giving full power for either high speed or hard low speed pulling. By this simple means, both maximum power and greater economy can be had without changing the carburetor adjustment.

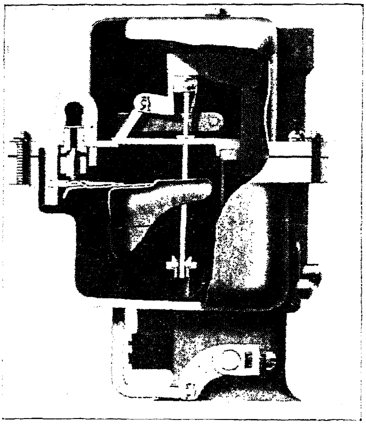


Fig. 151. Carburetor Metering Rod and Jet

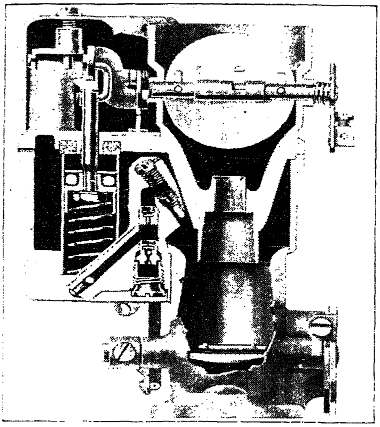


Fig. 152. Carburetor Choke Valve and Accelerating Pump

The choke consists of a butterfly valve, hinged in the center, one-half being spring controlled, Fig. 152. When fully choked, a trigger lock limits the movement of the spring controlled valve, admitting the right amount of air when the motor fires to keep the motor running. As soon as the choke is released slightly, the hinged half of the valve opens and acts as an air valve during the warming up period. This prevents overloading and produces a smooth running mixture with a cold motor. The accelerating pump, Fig. 152, is of the pneumatic type and consists of a cylinder with a plunger containing an air bell and two check valves, one on the inlet and one on the outlet side. The upward movement of the plunger, when the throttle is closed, draws a small metered quantity of fuel into the bottom of the cylinder. The slightest opening of the throttle causes an immediate discharge through a jet pointing downward into the main venturi.

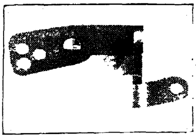


Fig. 153. Accelerating Pump Plunger Arm

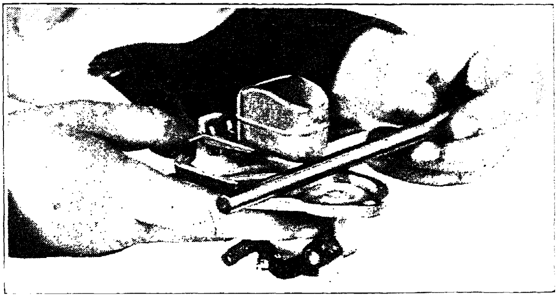


Fig. 154. Checking Carburetor Float Level

Carburetor Adjustment. There are two adjustments on the carburetor, one for idling mixture, and the other for idling speed. Both of these adjustments should be made together, having the engine thoroughly warmed up. To adjust the idling mixture proceed as follows: Open the idle adjusting screw from $\frac{1}{2}$ to 1 turn open; let the engine idle; try turning the screw both ways from this position until the best setting is made. To adjust for idling speed, proceed as follows: With the hand throttle on the instrument panel closed, set the throttle lever stop screw so that the engine runs at approximately 400 revolutions per minute. If the engine runs too fast, back the screw out, and if it runs too slow, turn it until the proper speed is obtained.

Accelerating Pump Adjustment. The lever which operates the accelerating pump plunger arm, Fig. 153, is provided with three adjustments or settings. Medium stroke is the correct setting for ordinary temperatures and standard gasoline. Short stroke is for use in extremely hot climates, at high altitudes, or with high test fuel. The long stroke is for use in extremely cold climates. To set this pump arm lever, it is necessary to remove the cover from the top of the accelerating pump. When this cover is removed, the countershaft that operates the accelerating pump should be lubricated with graphite grease. To do this, fill the cover screw hole with the grease.

Float Level. The float level, $\frac{3}{8}$ inch, should be maintained for the best economy. This measurement should be taken on the side of the float, opposite the gasoline intake needle and measured from the top of the float to the machined surface of the bowl cover, with the gasket removed. An easy method of measuring this level is by the use of a $\frac{3}{8}$-inch round drill rod, as shown in Fig. 154. If the float level must be reset, bend the lip that comes into contact with the gasoline intake needle. When the lip is bent up, it will lower the float level, and if bent down it will raise it. Only a slight bend is necessary to change the float level.

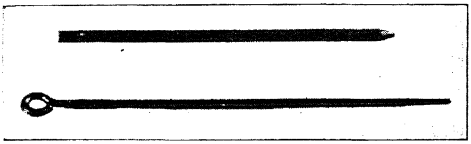


Fig. 155. Metering Rod

Metering Rods. The metering rod, which controls the amount of gasoline passing through the jet, can be changed to meet the various climatic, fuel, and driving conditions. These various sizes, which are listed below, are available through the parts warehouses and are marked as listed, Fig. 155. Production metering rods, which are the standard size, are not marked.

CADILLAC CARBURETOR

The Cadillac carburetors, Fig. 156, are of the expanding air vane type, and are simple in construction with no thermostats. They have only one adjustment which controls the mixture by varying the flow of fuel rather than the air.

The carburetors used on the various Cadillac models are of the same construction, but differ in size and other minor details. The 370-D and 452-D carburetors are identical with the exception of the size of the metering pin. Right and left carburetors also differ in the control levers. The name plate marking identifies the type of carburetor; 370-D carburetors are Type R-13 and L-13; 452-D carburetors are Type R-14 and L-14. Otherwise the carburetors on these car models are fully interchangeable. The carburetor consists chiefly of two units, the main metering unit and the auxiliary unit.

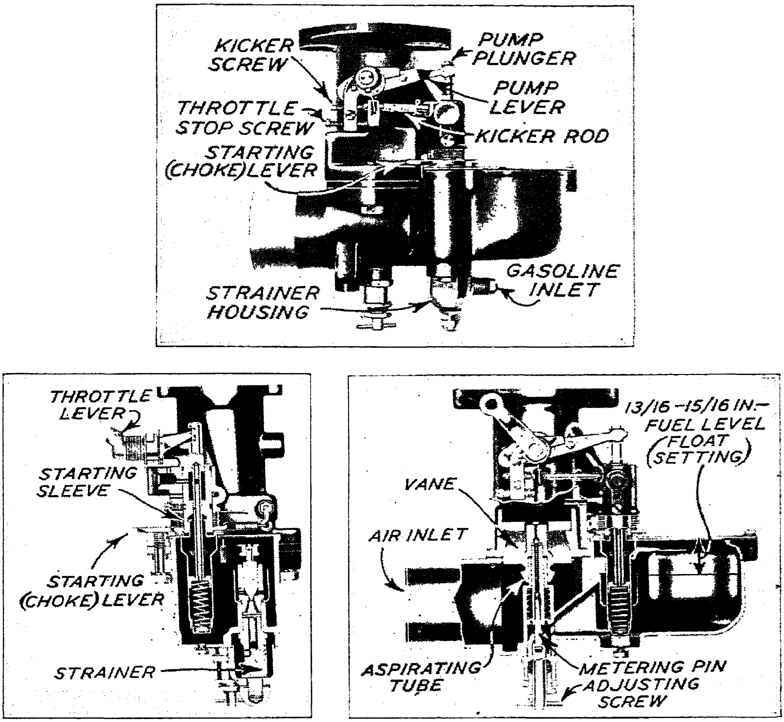


Fig. 156. Cadillac Carburetor and Sectional Views

Main Metering Unit. The main metering unit consists of a pair of air valves or vanes, hinged at their lower ends and opening upward to admit air to the mixing chamber. These vanes have fingers which engage a control aspirating tube, raising it as the vanes open. This aspirating tube is attached to a spring loaded hollow stem and piston working in a dashpot, the piston carrying the fuel metering orifice in its lower end. An adjustable tapered metering pin projects into this orifice.

Auxiliary Unit. The auxiliary unit combines an auxiliary power jet, an accelerating pump, and a priming passage for starting. The operation of the auxiliary unit is controlled by the registering of ports in the starting sleeve, which line up with passages in the throttle body. The starting sleeve rotates with the starting lever (choke lever) and the pump plunger and piston move downward as the throttle is opened. For normal running, the fuel enters the carburetor float bowl through the strainer and float needle valve, and it is maintained at constant level by the float and float needle valve.

Air. Air enters the carburetor through the air inlet and lifts the vanes as it passes upwards into the mixing chamber. The weight of these vanes, combined with the pressure exerted by the dashpot spring, causes a partial vacuum to exist in the mixing chamber, which draws fuel from the aspirating tube. The quantity of the fuel flowing is controlled by the tapered metering pin. At idle speed, the vanes are almost closed and the metering pin almost fills the orifice in the air valve piston. As the vanes rise to admit more air, the aspirating tube also rises and the metering orifice becomes larger, due to the taper on the metering pin. This combination maintains the correct ratio of fuel and air for average running.

Power. For maximum power at any speed, a richer mixture is required than is necessary for part throttle running. The power jet supplies the required extra fuel, while the throttle is held open beyond the point which would give a road speed of about 60 miles per hour. At this throttle position, the pump plunger has traveled downward and has shut off the air vent to the power jet, therefore, the suction on the discharge nozzle draws fuel from the pump cylinder up through the hollow stem of the pump plunger and through the power jet into the mixing chamber. At part throttle positions below 60 miles per hour road speed, this power jet does not supply fuel since it is vented to the outside air through the air vent hole in the upper part of the starting sleeve. The quantity of fuel drawn from the power jet is controlled by the air bleed hole in the pump plunger stem.

Acceleration. For rapid acceleration, it is necessary to supply a momentarily rich mixture. This extra fuel is supplied by means of the accelerating pump. A rapid opening of the throttle causes a rapid downward movement of the pump plunger and piston, forcing fuel up through the hollow stem of the pump plunger and out through the discharge nozzle into the mixing chamber. The fuel in the pump cylinder cannot escape back into the float chamber because of the check valve in the bottom of the pump cylinder. In general, for steady driving conditions up to 60 miles per hour on level roads, the fuel is all supplied from the aspirating tube. When the throttle is opened suddenly, an additional charge of fuel is supplied from the accelerating pump, and if the throttle is held open as for hard pulling or high speed, extra fuel continues to flow from the pump discharge nozzle through the power jet.

Choke. All Cadillac cars are equipped with a semi-automatic choke, which permits a more efficient choking of the carburetor during the warming up period than is possible with a manual choke control. When the engine is cold before starting, the semi-automatic choke is automatically in the choke position. The manual choke on the instrument panel should be used as necessary when starting a cold engine, but it should be pushed in immediately after the engine starts. The purpose of the semi-automatic choke is to keep the engine from stalling and to prevent popping back into the carburetor before the engine has reached the proper operating temperature. As the engine warms up, the thermostat starts to open the choke so that when the engine has reached its correct operating temperature, the semi-automatic choke is in full open position.

AUTOMATIC CARBURETOR CHOKE

A Stromberg carburetor and an automobile intake manifold in phantom view with the Stromberg automatic choke in bold relief are shown in Fig. 157. This automatic choke is designed to eliminate entirely the need of hand choking an automobile when starting or otherwise operating it. Its operation is wholly governed by vacuum and the heat of the engine, and the part played by each of these should be continually kept in mind.

The action of the choke is very quick, being vacuum controlled. Its opening operation is controlled by the heat, which allows the choke valve to open the correct amount during the warming-up period of the engine.

The thermostat, which appears in the nature of a coiled spring on the face of the device, returns the choke valve in the carburetor to closed position when the thermostat reaches a temperature of 70 degrees Fahrenheit.

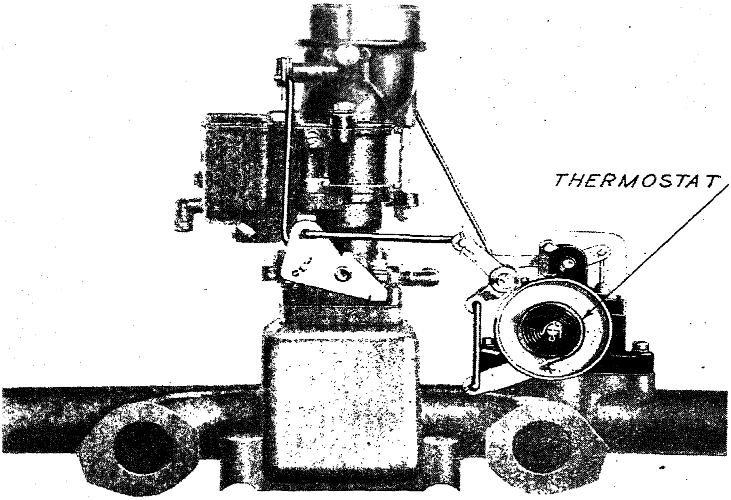


Fig. 157. Stromberg Automatic Carburetor Choke

The choke valve is closed during the cranking of the engine and is held so by the locking of a roller against a cam. When the engine fires and a manifold vacuum is created, a vacuum piston within the device is pulled part way down, thus unlocking the cam and the roller.

As the engine starts to operate smoothly, an even vacuum will be present and the piston within the device will travel its remaining distance, operating another lever off of the cam, which opens the choke a predetermined distance against the tension of the thermostat spring.

The distance between the lever and the cam is an adjustable one. When the motor has reached a water temperature of 120 degrees Fahrenheit, the choke valve should be in a wide-open position. If it should not be found in such a position, adjustment should be made to compensate for it.

BENDIX STROMBERG AUTOMATIC CHOKE CONTROL

General Description. The Stromberg automatic choke control is a device that eliminates all methods of hand operated chokes. Its operation is wholly governed by vacuum and heat of the engine, which makes it positive acting under any conditions. It acts quicker than any choke can be operated by hand and allows the carburetor choke valve to open the correct amount during the warming up period of the engine.

Principle of Operation. This principle of operation is shown in diagrams 1, 2, 3, and 4, Fig. 158. The thermostat *A*, Fig. 158, returns the choke valve in the carburetor to closed position when the thermostat reaches a temperature of 70 degrees. The choke valve is closed during the cranking of the engine and held so by the locking of linkage *K*. When the engine fires and a manifold vacuum is created, the vacuum piston *B* is pulled down, and through the lever *D* unlocks linkage *K*. From then on, the choke valve opens against the tension of the thermostat *A*. When the motor has reached a water temperature of 120 degrees, the choke valve should be in wide open position.

Adjustments. The choke is not a delicate instrument, but, when servicing, it should be given the same consideration as any fine part of the engine. For adjusting the automatic choke control for any reason whatsoever, it can be quickly and accurately done by following very carefully the procedure outlined below:

1. Remove the automatic choke from the motor by disassembling the carburetor choke rod and accelerator rod connected to the safety release lever.

2. Under any conditions, the thermostat *A* should be allowed to cool or warm until it has reached a temperature of 70 degrees. This is very important and, if the car has been running, it is necessary to allow the automatic choke to stand long enough to cool off, or on the other hand, if the place or garage where the choke is to be adjusted is colder than 70 degrees, the choke should be taken into a room of normal temperature.

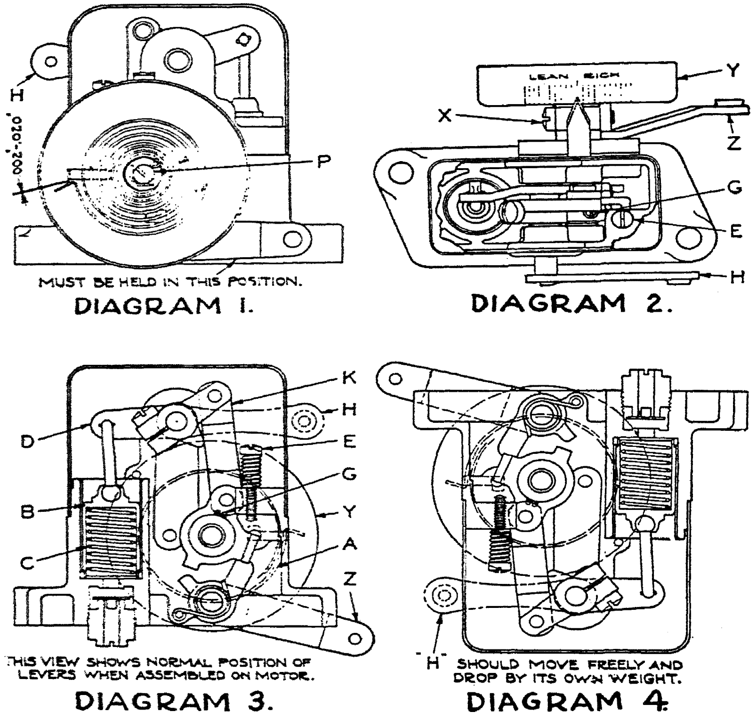

H
.002"-.020"
P
MUST BE HELD IN THIS POSITION.
DIAGRAM 1.
LEAN RICH
Y
X
Z
G
E
H
DIAGRAM 2.
K
H
D
E
G
B
Y
C
A
Z
THIS VIEW SHOWS NORMAL POSITION OF LEVERS WHEN ASSEMBLED ON MOTOR.
DIAGRAM 3.
"H" SHOULD MOVE FREELY AND DROP BY ITS OWN WEIGHT.
DIAGRAM 4.

Fig. 158. Bendix Automatic Choke Control

3. During the entire check of the automatic choke, it is necessary to hold the safety release lever *Z* in horizontal position (even with the base), diagram 2, Fig. 158.

4. Unhook the thermostat *A* from the hook, set case *Y* five notches lean for the Olds F-32 and eight notches lean for the Olds L-32 (this will differ for various installations), and with the lever *H* in the uppermost position, there should be from .002 inch to .020 inch space between the hook and prong of the case. If this space needs to be adjusted, loosen screw *G* and turn shaft *P*. Fasten the screw *G* securely, observing that the thermostat does not rub against the case *Y*.

5. Hold the automatic choke in an inverted position. Lift up the lever *H* and let it drop. It must drop freely and by its own weight. Observe if linkage *K* comes back to lock position.

6. Assemble the thermostat on the prong, returning the case *Y* to zero position.

7. With this setting, lever *H* should catch in the choke closed position but should yield to a light pressure. Revolve case *Y* one-quarter turn (prong will be under pointer). With this tension, lever *H* should resist a light pressure, but it should yield to a tap of the hand. There should be a noticeable difference in the settings. If the catch of lever *H* is to be changed, adjust screw *E*. Turning screw *E* IN or clockwise, will cause lever *H* to offer less resistance, turning screw *E* OUT will increase the catch of lever *H* in the choke closed position.

8. Fasten screw *X* securely.

9. Piston *B* should work freely and should show no signs of sticking in any position. When piston *B* is pushed down, it should unlock linkage *K*.

10. Assemble the cover on the body. Before tightening the screw, make certain that the cover plate is not assembled so that it will bind against the shaft.

11. Assemble the choke control on the manifold, fastening screws securely.

12. Assemble connecting rod between choke control and carburetor so that there is only .006 inch backlash between levers. If it is necessary to adjust, loosen the clamp screw of the carburetor choke lever. Assemble the accelerator rod in lever *Z*.

13. Assemble the air cleaner so that it will not interfere with the carburetor choke lever.

14. Make a final check on your work and test the job.

1934 OLDSMOBILE 8 STROMBERG MODEL "H" AUTOMATIC CHOKE CONTROL

Principle of Operation. The thermostat *A*, referring again to Fig. 158, returns the choke valve in the carburetor to closed position when the thermostat reaches a temperature of 70 degrees. With this action the vacuum piston *B* is raised so that it is ready for a start. Lever *F* comes to rest against adjustment screw *E*. The choke valve is closed during the cranking of the engine and held so by the locking action of linkage *K*. When the engine fires and a manifold vacuum is created, vacuum piston *B* is pulled down. With it lever *D* is moved down which forces the choke valve to open a predetermined amount. Lever *H* is on the same shaft as lever *D*, and is connected to the choke valve by a connecting rod.

Adjustments. This type of automatic choke control requires very little attention. It is only necessary that all operating linkage moves freely and does not bind in any position. This is particularly necessary with the connecting rod between the carburetor and the choke control. Freeness of the rod should be checked in both the wide open and closed positions. With the lever of the automatic choke in the uppermost position and the choke valve closed, there should be only .006 inch backlash in the hook-up. If necessary to reset, it can be done by moving the carburetor choke lever to give the desired amount.

The adjustment screw *E* is set at the factory to give the desired amount of locking linkage *K* and it should not be necessary to tamper with this adjustment. Therefore, the only adjustment that should be checked is the thermostat. When checking this, it is necessary that the thermostat be allowed to cool or warm until it has reached a temperature of 70 degrees. This is very important and, if the car has been running, it is necessary to allow the automatic choke to stand long enough to cool off, or, on the other hand, if the place or garage where the choke is to be adjusted is colder than 70 degrees, the choke should be taken into a room of normal temperature.

When the thermostat has reached 70 degrees, remove the hook from the prong of the thermostat case. Revolve the case so that the zero marking is directly in line with the thermostat pointer. In this position, the end of the hook should come flush with the prong. If this space needs to be adjusted, loosen the set screw in lever *F*, and move the thermostat to the desired position. Fasten the set screw securely. Place the hook of the thermostat on the prong and revolve the case three notches rich.

When servicing the automatic choke control, it is also important that the gasket between the base and the intake manifold is in good condition, and that the choke attaching screws are screwed down evenly so that there is no leakage around the channel leading to the vacuum piston.

Engine Hot or Cold—Slow Idle. The slow and fast idle, Fig. 159, on the eight cylinder carburetor is controlled through the action of arm *A* which determines the location of idle adjusting screw *C*, on the three steps of the arm. The choke valve in the carburetor is hooked up to the thermostat, which regulates the opening and closing of the choke valve, according to the temperature of the engine, or the thermostat spring. Pin *G* is fastened to the choke valve shaft and revolves with it when the choke either opens or closes. Arm *A* is moved up by pin *G*, bearing against the lug *J*, located on arm *A*. Arm *A* will fall of its own weight when pin *G* drops, or the choke valve is opened.

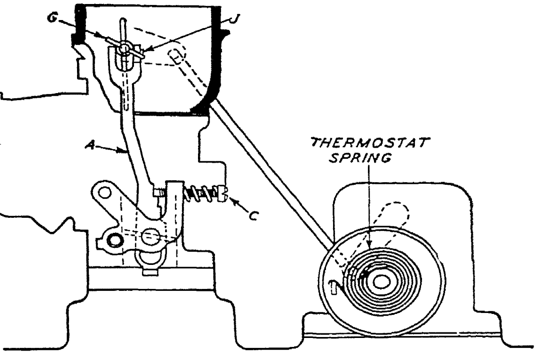


Fig. 159. Slow Idle Control

As the engine becomes cold, the thermostat of the choke control gradually gains tension and will tend to close the choke valve. Pin *G* revolves with the choke shaft and lifts with it arm *A* until its movement is stopped by the notch on the arm *A*, coming in contact with the adjustment screw *C*.

Engine Cold—Fast Idle. As soon as the starter button is depressed, the pick-up on the starter rod partially opens the throttle, at which time the arm *A*, is freed and the tension of the thermostat spring entirely closes the choke valve. The screw then rests on the stop shown in Fig. 160, on the extreme fast idle position. During the cranking of the engine the carburetor and choke control remain in the position as shown in Fig. 160.

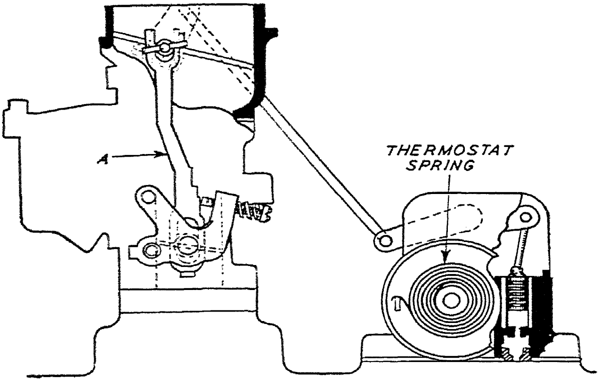


Fig. 160. Fast Idle Control

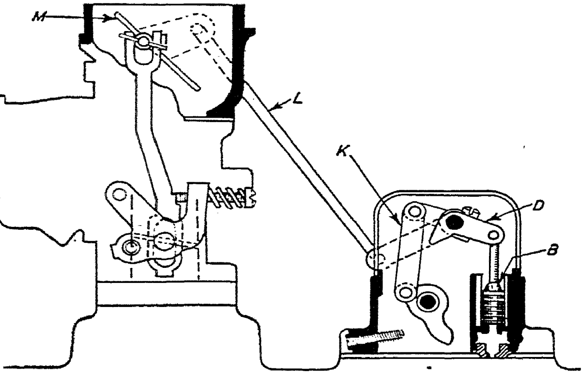


Fig. 161. Intermediate Idle Control

Engine Warm—Intermediate Idle. As soon as the engine starts to fire, the manifold vacuum pulls the piston *B* down, Fig. 161. Lever *D* is forced down and breaks linkage *K* to move rod *L*. This partially opens the carburetor choke valve *M* to admit air for proper running mixture. As the engine warms up, the choke valve is opened entirely by the inrushing air as the tension of the thermostat becomes weakened from the heat of the exhaust manifold.

Engine Flooded—Throttle Wide Open. If, for any reason, the engine should become loaded by excessive cranking, and fail to start, it can be cleaned out by holding the accelerator pedal in wide open position and allowing the starter to turn over the engine a few times. Opening the throttle wide, revolves the lever *N*, Fig. 162, so that it contacts with ear *P* on the bottom of arm *A*, which forces the arm down, bringing lug *J* in contact with pin *G*.

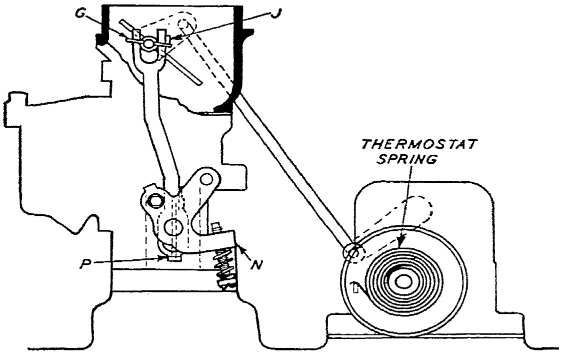


Fig. 162. Relieving Flooded Engine

DE SOTO AUTOMATIC CHOKE

An automatic choking device is provided which operates the carburetor choke when starting and during the warm-up period. A control button is provided on the instrument panel for emergency use, in case the engine becomes loaded while starting. If the engine does not start readily, press the button "in" and hold while continuing to crank the engine. This allows the choke to open slightly and avoids flooding.

To adjust the automatic choke, remove the air cleaner from the carburetor, and the cover from the automatic choke. Next, clamp the adjusting tool in place, so the pin in the tool enters and lines up the two holes in the armature and magnet core of the unit, locking the armature in the closed position. Then loosen the arm on the choke unit operating shaft and while holding the lever down inside the unit, to remove backlash, set the choke blade in the closed position and tighten the clamp screw in the choke operating arm.

Before removing the setting tool, check the choke for backlash by grasping the choke rod and pushing lightly back and forth. If there is no evidence of backlash, adjustment is correct.

CARBURETOR TROUBLES AND REPAIRS

Operation Troubles. The basis of good engine operation has been given as good compression. The basis for economical operation is good carburetion, and it cannot be obtained unless the symptoms of incorrect carburetion, carburetor troubles, and their effect on engine operation, are known and understood. The following is a summary of troubles due to carburetors and their action on engine operation and their cures.

Spitting Back through the Carburetor on Sudden Acceleration. This may be caused by two things. (1) Weak mixture, due to incorrect adjustment of the carburetor. The cure is to readjust the carburetor. (2) Air leaks in the intake manifold or stoppage in the gasoline supply. Air leaks in the intake system can be in two or three places. One at the intake-manifold joint can be tested in the following manner. Take an oil can and fill it with gasoline and squirt the gasoline around the joints. If the engine runs better after this treatment, the trouble is at these joints. Air will also leak in at the intake valves if they are worn, which will necessitate new guides being installed. If the mixture must be made very rich to have the engine run smoothly, it will often indicate worn intake-valve guides. If the carburetor butterfly-valve shaft is badly worn in the bushing, a great deal of air will be drawn in that will upset any kind of adjustment that may be made with the carburetor adjustments, and the only cure is the fitting of new shaft and bushings to the carburetor. If on trying the adjustments no change can be noticed, it is a good plan to examine the butterfly shaft and bushings. Stoppage of the gasoline supply can be caused by the strainer being clogged up with dirt or lint. To cure this trouble it will be necessary to take the instrument apart and clean every part thoroughly.

Uneven Running at High Speeds with Black Smoke Coming from the Exhaust. This indicates too rich a mixture and the engine will tend to run in the following manner: There will be a series of explosions followed by a period of rest. These periods follow each other quickly with every cylinder firing during the time the explosions are taking place. It is termed "galloping." If more air makes the engine run evenly, readjust the carburetor.

In systems where vacuum tanks are used, it often happens that the valves inside the vacuum tank will fail to operate correctly so that the tank will fill up and raw gasoline will be drawn through the suction pipe into the intake manifold and a very rich mixture will result. In testing, disconnect the suction pipe and place a finger over the opening in the intake manifold. If the engine runs better, then the vacuum tank must be overhauled.

In the case of the cork float type of carburetor, the float may be soaked with gasoline and is too heavy to shut off the gasoline at the correct level, causing too rich a mixture. Dry the float and give it a thin coating of shellac, being careful not to make the float too heavy. A metal float may be punctured and filled with gasoline. This will make it too heavy to function correctly, causing the carburetor to flood. It is best to install a new float in this case. A temporary repair may be made by immersing the float in very hot water. This will vaporize the gasoline inside the float and the hole can be found. The hole can then be covered with a very thin layer of solder. Care should be taken that the float is not thrown out of balance or it will stick in the float chamber. Too rich a mixture can also be caused by the choke valve sticking or not working correctly due to some mechanical trouble such as a broken choke wire, which should be renewed.

Missing at Low Speeds. This trouble is usually caused by air leaks. Another cause is the dilution of the charge by exhaust or burnt gases. If the exhaust valve leaks, some of the exhaust gases will be drawn back into the cylinder as the piston goes down on the suction stroke. The low speed or idling speed fuel charge is very small, and a very small quantity of burnt gas drawn back into the cylinder will dilute the charge and cause missing at low speeds. The dilution of this charge will often cause missing even up to a speed of 30 miles per hour. The trouble is not exactly a miss but rather a weak explosion, which makes it seem like a miss and causes the engine to run unevenly.

Missing at High Speeds. This trouble may be caused by stoppage in the gasoline supply or by valves holding open. Water in the gasoline may also be a cause. The supply system should be cleaned out and the valve clearance checked. If there is water in the gasoline, the carburetor should be drained. The presence of water will be shown by little bubbles separating themselves from the gasoline. The gasoline should be poured back into the tank through a chamois skin.

No Power on a Hill Climb. When a car runs well on the level but will not pull on coming to a hill, it is an indication of a stoppage in the gasoline supply. The cure for this has been given. In high altitudes an engine seems to lose power due to the compression volume being less than in low altitudes.

Engine Overheats. Too rich a mixture may be the cause and the cure for this has been given. In high altitudes an engine will heat because of the lower boiling point of water as well as because the air is less dense which causes the mixture to be richer.

Engine Starts and Then Stops. This may be caused by dirt in the jet. The engine will start but as quick as the suction comes particles of dirt will be drawn into the jet opening and gasoline will be prevented from passing through the opening. The carburetor should be cleaned out. This same trouble may be caused by the gasoline level being too low.

Engine Will Not Start. See that the gasoline is getting through to the carburetor—if there is any in the tank—by raising the needle valve and seeing if the carburetor floods or the gasoline runs over the top of the float bowl. If there is gasoline in the carburetor, the trouble must be in the ignition system, unless the adjustment of the carburetor is entirely out of order. When starting the engine, excessive use of the choke should be avoided because it floods the engine with raw gasoline and makes it still harder to start. It also causes a great deal of carbon to form as well as causing crank-case dilution. It will also wash the oil off of the cylinder walls and gives a chance for the cylinders to score. In very hot weather the engine will lack pep or operate sluggishly. If the heater pipe is disconnected or some of the heat shut off from the carburetor, the operation of the engine will be greatly improved. It is a good plan to crank the engine in cold weather with the switch in the "off" position so that a charge of gas can be drawn into the cylinder before the switch is turned on. The clutch pedal should also be pushed down because the starter will not have to pull against the heavy oil in the transmission and it will give the spark a better chance to fire the cold gasoline. After the engine has started, the mixture should be set so that the engine will run evenly. The engine should be allowed to warm up before the car is driven. This not only prevents the intake of raw gasoline, but also gives the oil a chance to warm up and start circulating.

Misfiring or Backfiring in Muffler When Descending a Hill. When coasting down a hill with the gears in mesh, the trouble of backfiring in the muffler is often experienced. This trouble is also caused by charge dilution. If the exhaust valves do not seat properly, some of the exhaust or burnt gases will be drawn back into the cylinder and dilute the charge. The throttle being closed, the charge is very small and the least little dilution upsets the explosion and makes it a very slow burning mixture. A weak spark will also cause this firing in the muffler.

Mechanical Troubles and Cures. The height of the gasoline is an important item in the operation of the carburetor. The correct level for the gasoline in the jet is on a level with the top or with a bead of gasoline on the top of the jet. The level is controlled by the length of the needle above or below the collar on the needle valve, Fig. 163. If the length of the needle is increased below the collar, the valve will shut off earlier and the level will be lower. If the length of the needle is decreased below the collar, the valve will shut later and the level will be higher. The result of too high a level will be flooding, while too low will cause hard starting or no starting at all. Fig. 164 shows how the level of the gasoline can be tested. In most carburetors the body of the device can be removed and the jet exposed to view. Take a small tank and place it up high so that there will be a good deal of pressure behind the gasoline. Clamp the carburetor in a vice so that it is level. Connect the tank with the carburetor and allow the liquid to flow into the float bowl. If the gasoline runs over, the level is too high and the length of the needle below the collar should be increased.

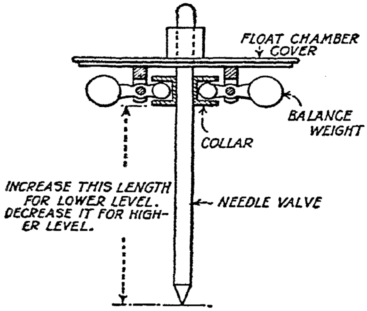

FLOAT CHAMBER COVER
BALANCE WEIGHT
COLLAR
INCREASE THIS LENGTH FOR LOWER LEVEL. DECREASE IT FOR HIGHER LEVEL.
NEEDLE VALVE

Fig. 163. Gasoline Level Control

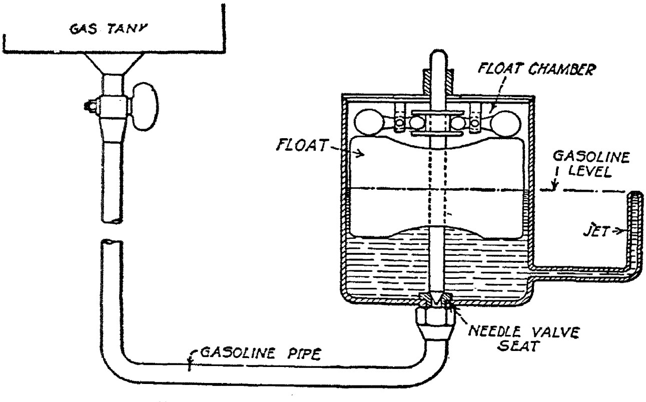


Fig. 164. Testing the Level of Gasoline

If the liquid cannot be seen in the top of the jet, the level is too low and the length of the needle below the collar should be decreased. In decreasing the length of the needle, the point of the valve should not be damaged or the needle will never seat. In the cork or hinged-type of float, the hinge of the float must be bent or altered to correct the gasoline level.

Another cause of flooding is a worn needle valve and seat. If the needle is not badly grooved, it can be lightly ground to fit the seat again by the use of ground glass and oil. The best and cheapest plan is to install a new valve and seat. The needle valve seat is screwed into the carburetor body at the bottom of the float bowl. Particles of dirt will lodge on the valve seat and prevent the proper closing of the valve, causing a gasoline leak. If the body of the carburetor is wet, it does not always indicate that there is a leak because with the heavy fuel in use today, there is always dampness around the body which dries when the engine is started. The body remains dry as long as the engine is warm.

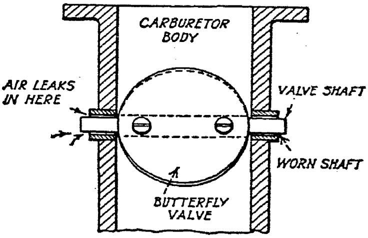


Fig. 165. Worn Butterfly Shaft and Bushings

Worn Butterfly Shaft and Bushings. Fig. 165 shows this condition and the only cure is to install new shaft and bushings. This trouble will upset any adjustment that is made on the carburetor because a great deal of air can be drawn into the manifold above the point at which the gasoline and air are mixed. Therefore the mixture is thinned out considerably.

Butterfly Valve Loose on Its Shaft. This trouble will cause a fluttering action when the engine is accelerated and the action of the engine will be uneven. It will also cause the throttle to remain open and the engine would race even after the throttle lever or accelerator pedal had been returned to the closed position.

Choke Valve Loose on the Shaft. This would either cause too rich a mixture because it failed to open after the choke lever had been moved to the open position or the engine would be very hard to start because the choke valve could not be closed to give the rich mixture necessary for starting. Examine the choke wire and the screws that hold the valve on its shaft. Replace them if they are lost or tighten them if they are loose.

Float Failure. Float failure within the carburetor or the vacuum tank is the cause of trouble which frequently defies diagnosis on the part of the mechanic. The logging of the carburetor float or the vacuum tank float will result in a fuel mixture which is overrich. The logged carburetor float will cause the carburetor to flood when the car is standing idle. A logged vacuum tank float makes trouble when the car is running.

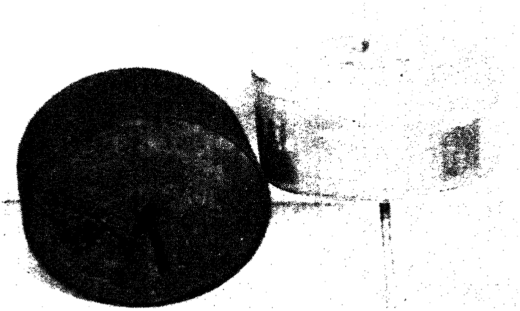


Fig. 166. Vacuum Tank Floats
Left—One which has failed from corrosion.
Right—A new vacuum tank float.

A vacuum tank float which has corroded and rusted thin with eventual failure is shown at the left in Fig. 166. The float appearing at the right is a new one in good condition. When metal floats fail, it is usually due to some very small opening or leak. Over a long period of time fuel keeps seeping in. When the float is removed from the carburetor and shook near the ear, the sound of the fluid in the float is evident. In order to effect a repair, the best plan is to discard the old float and replace it with a new one. In case the float has to be repaired, the first thing to do is to locate the opening through which the fuel enters. In order to do this, place a pan of water on the stove and when it has come to the boiling point immerse the float in it. Since the gasoline will vaporize at a point lower than that at which water boils, bubbles will appear emerging from the point at which the leak has occurred. Mark this point.

Enlarge the original leak with a scriber or center punch. At another point, directly opposite this one, punch another hole. The second hole affords a vent for the air to enter while draining the gasoline off. Now proceed to solder both of the holes shut. Then the test given above should be repeated in order to learn whether the job is air tight.

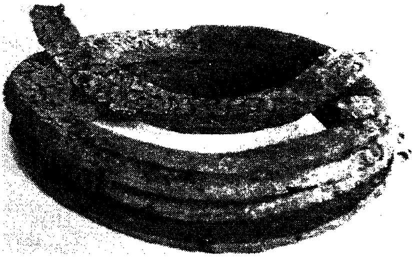


Fig. 167. A Hinged Type Cork Float Which Separated after Losing Its Shellac Coating

Cork floats are constructed of a number of layers of cork which are glued together. The entire outer surface of a cork float is protected by means of a high grade of shellac. When this shellac fails, for any reason, the layers of the cork may become separated, as in the case of the float shown in Fig. 167. The only remedy, of course, is to replace this type of float with a new one, once the damage has become so great. It sometimes happens that the shellac will start to disintegrate and show evidences of failure before the damage is beyond repair. When a float in this condition is met with in service, it is a good plan to re-shellac it to prevent future trouble.

Generally it is not a good plan to try to dry out a fuel logged cork float. Some mechanics, however, have made repairs to the fuel logged cork float by first drying it in an oven or over a hot plate, and then shellacing it. This procedure is not recommended except in case of the greatest emergency.

Cleaning the Carburetor. Cleaning the carburetor should be done very carefully until one becomes quite familiar with it and with the influence which movement of the various parts will have. First, the gasoline supply should be shut off between the tank and the carburetor so that the supply of gasoline may be saved; second, disconnect the priming arrangement; third, remove the top part of the float chamber. In taking off the top, the cover should be loosened and then lifted straight up until clear of all remaining parts. With the cover off, the float may readily be removed in the same way, the only care being in starting it. As the amount or length of the needle point within the tapered seat is small, the float need be raised but a small amount.

COOLING SYSTEMS

Heat and energy are closely interrelated. In order to develop power or energy within the gasoline engine, it is necessary to have the fuel burned. The burning or combustion of the gasoline and air mixture results in very high temperatures being developed. Part of the energy developed by this combustion is used up in the power generated. A very large percentage of it must be dissipated through some cooling means. Engineers are always hoping for the time when a larger percentage of the power developed with the burning of the fuel can be utilized. In order to make use of the principles of the internal combustion engine, considerable thought has had to be exercised with reference as to what should be done with the unused heat energy and how it might most efficiently be dissipated without harmful effects to the mechanical parts of the power plant.

Parts Cooled. The parts of an engine requiring cooling are illustrated in Figs. 1 and 2. In Fig. 1, which is a cross section of a water-cooled job, it will be noted that the spark plug, valve, piston, and piston rings are shown along with the cylinder, the cylinder head, valve port, valve guide, and attendant parts. These are the main parts which require efficient cooling.

When the explosion occurs within the cylinder head, a very high initial temperature is developed. The burning gases will show a temperature running well over 2000° F. These burning gases are playing upon the piston head and within the combustion chamber. When the exhaust valve opens, they are playing around the valve stem and seat and through the exhaust port. The spark plug points are in close contact with them; in fact, every surface within the exhaust manifold or within the combustion chamber is subject to them. These gases are actually hotter than the melting point of certain of the metals used in the construction of the engine. If they were continuous rather than intermittent, the difficulty of cooling the engine would be much greater.

One of the situations taken advantage of with reference to cooling engines is the admission of relatively cool gases to the combustion chamber in each cycle of the engine. This holds with reference to two-cycle and four-cycle engines alike. The cool gases, of course, are likewise in immediate contact with the various parts so that they

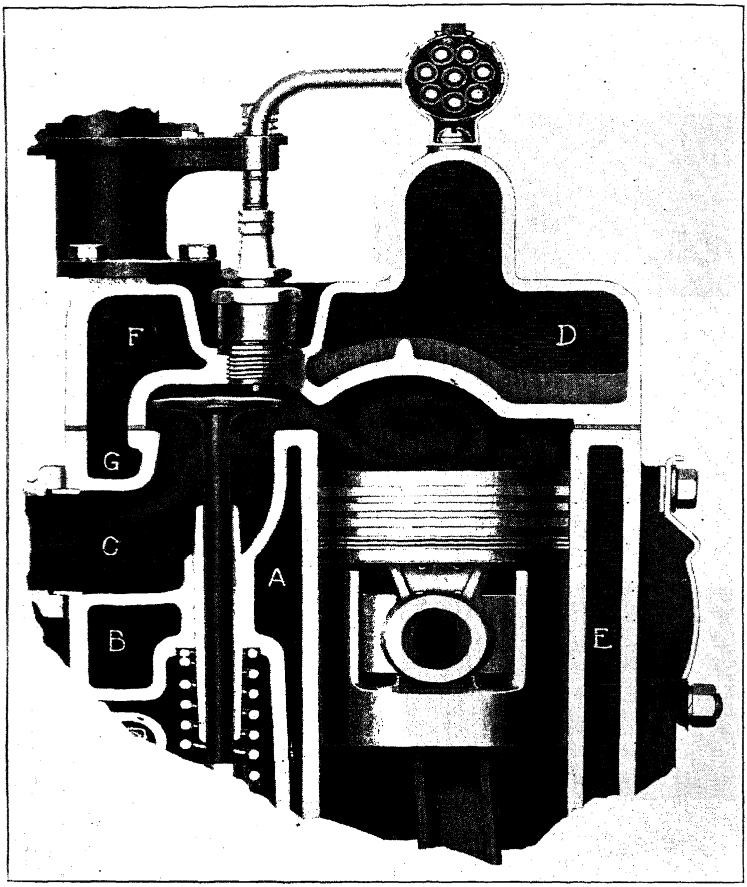


Fig. 1. Parts Which Must Be Cooled

serve to reduce the operating temperature of the parts by immediately absorbing a certain amount of the heat which has been left within the metallic parts by the high temperature of the exploding gases. The effect of the cooled incoming fuel charges is not sufficient to hold the engine parts at a low enough operating temperature to prevent failure of the engine due to overheating.

Types of Cooling Systems. In the case of an engine of the general characteristics of that shown in Fig. 1, we have what is termed a water-cooled engine. Water is used as an element or medium for transferring the heat from the metallic parts of the engine to the radiator, from which point the heat is dissipated into the air by means of the cooling fins of the radiator and the currents of air which are forced through it by driving or by the action of the fan.

By referring to Fig. 1, it will be noted that definite provision has been made for using water in jackets surrounding the parts which require cooling. The cylinder is surrounded by the water jackets *A* and *E*. Heat within the cylinder is carried through the cylinder wall into the cooling water. Heat which strikes the piston head is first transmitted to the piston body from which point it flows to and through the oil film surrounding the piston and thence into the cylinder wall and to the water. Spark plugs are set into the cylinder head in most cases. The water spaces in the cylinder head are shown at *F* and *D*. It will be noted that the spark plug is effectively cooled by this body of water. This same body of water also conducts away much of the heat which is developed within the combustion space since, unlike the cylinder walls, it is always in contact with the gases in the combustion chamber.

Valves are subject to burning if they are not properly cooled. Cooling the valve seat requires very careful designing. Heat which is taken up by the valve is held within it until such time as the valve is in contact with the valve seat. This metal contact between the valve head and valve seat is the only direct means of valve cooling. It is very likely true that the valve operates at a higher temperature than any other part of the engine. It can also be seen that if the valve seat is not in good condition, the heat is not readily dissipated from the valve into the cylinder block metal. In the case shown in Fig. 1 when the valve is seated, the heat then flows into the metal surrounding the water jackets *A* and *G* and is picked up by the water to be dissipated by the radiator.

In order to keep the valve guide at a satisfactory working temperature, some manufacturers, as in the case of the engine, Fig. 1, make use of a water jacket surrounding this guide. This dissipates or carries away much of the heat which finds its way into the valve stem.

Oldsmobile Cooling System. The Oldsmobile system of water cooling is representative of good design. The water pump which is located at the front of the cylinder block and is driven by the fan belt, is used to discharge water into a manifold tube which lies along the center of the length of the cylinder block in the water jacket. The water distribution manifold tube is on the right side of the cylinder block between the valves and the cylinder barrels. Holes

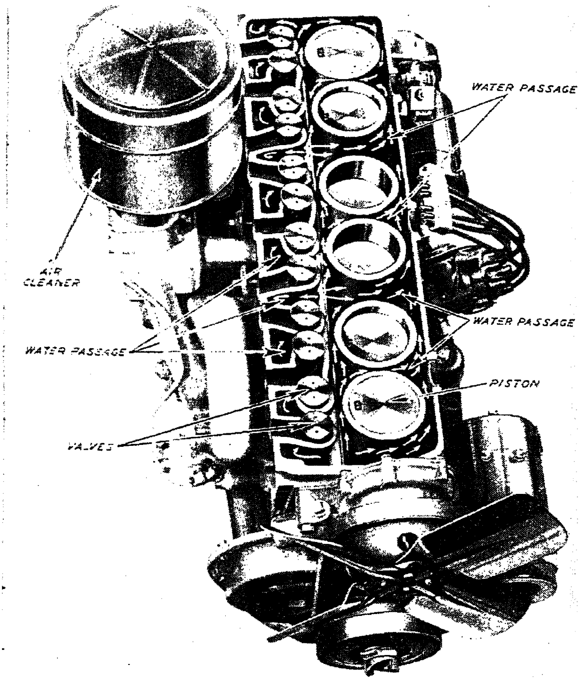


Fig. 2. Oldsmobile Engine Cooling System
Courtesy of Olds Motor Works

in the side of the manifold and slots along the top of it distribute the water around the valves as shown in Fig. 2. In this view, the top of the cylinder casting has been cut away so as to show the cylinder barrels with the pistons in them and the valve in their valve ports. It will be noted that the direction of flow of the cooling water is indicated by white arrows. Water thrown into the manifold tube by the pump is coming from the bottom of the radiator, to which point it has settled, as it has been cooled. Heat picked up by this cooling water, as it circulates around the cylinder barrels and around the valves, is carried with the water as it rises around these parts and flows off through the manifold at the top of the cylinder head. From the top of the cylinder head, the water is carried to the upper tank on the radiator, from which point it is distributed over the radiator core. As it gradually settles down through the passages of the radiator, it is cooled and again comes to the bottom of the radiator into the lower radiator tank, from which point it is distributed again as indicated above.

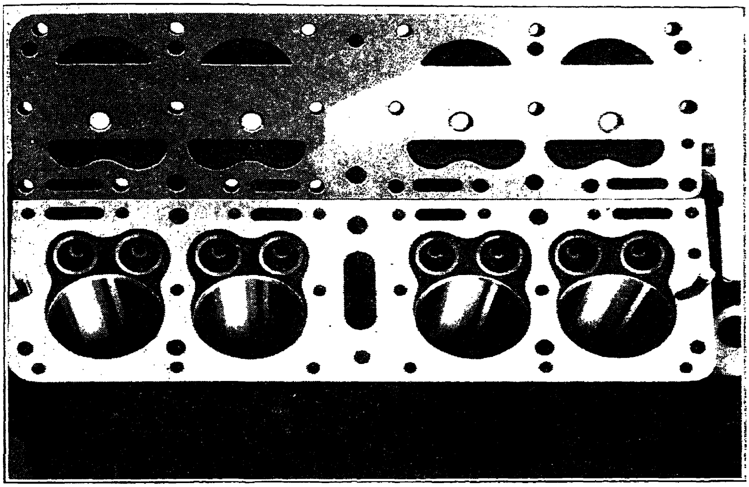


Fig. 3. The Water-Circulating Holes or Ports in the Block and Cylinder Heads Must Meet and Match

Cylinder=Head and Cylinder=Block Joints. When the workman understands the vital necessity of having the water passages in the cylinder block and cylinder head properly matched and open, he will understand why it is so essential that the proper cylinder-head gasket be used. It sometimes happens that gaskets are reversed on an engine with the result that part of the water passages may be closed off. In such cases it is impossible for the water which is brought in at the lower portion of the cylinders to circulate up into the cylinder head and thence back to the radiator. Fig. 3 shows the

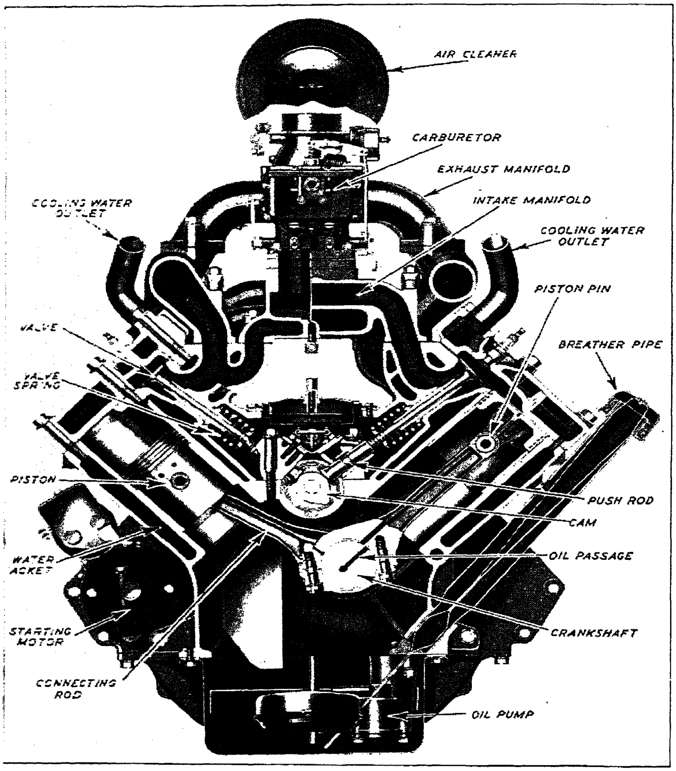


Fig. 4. Cadillac 90° V-8, Series 36-60, 70 and 75 Engine
Courtesy of Cadillac Motor Car Company

water circulating holes between the cylinder block and the cylinder head. When studying this figure do not mistake the spark plug holes and cylinder bolt holes for water passages. The water passages are elongated.

Even Temperatures Maintained. The best operating temperature for a water-cooled engine is generally stated as 170° to 190° F. At this temperature the fuels are vaporized in better fashion and the engine operates more evenly due to a better vaporization. Water jackets of the V-type Cadillac are illustrated in Fig. 4. It will be noted that the water completely surrounds the cylinders, the combustion space, spark plugs, valves, and the intake and exhaust ports. Not only does the water conduct the heat away from the engine, but it serves to equalize the temperature throughout the engine. The incoming gases will then be warmed in a desirable fashion. This distribution of heat within the engine, owing to the circulation of the water, is a desirable feature since it serves to keep the inner mass of metal evenly heated and allows for even expansion without the

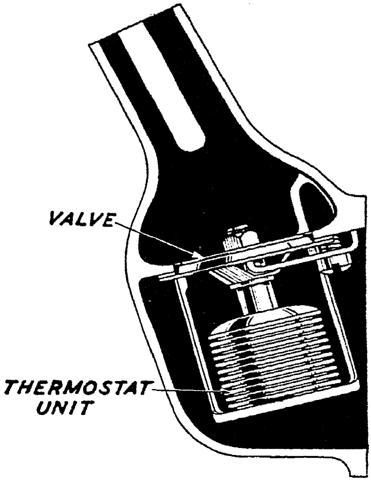


Fig. 5. Cooling System Thermostatically Controlled Valve for Circulation Control
Courtesy of Chevrolet Motor Company

warping of the metal, which would occur if they were not at approximately an even temperature.

Thermostats. Use of thermostat, Fig. 5, within the cooling system is of long standing. Each season has seen the adoption of it as standard equipment by an increasing number of manufacturers.

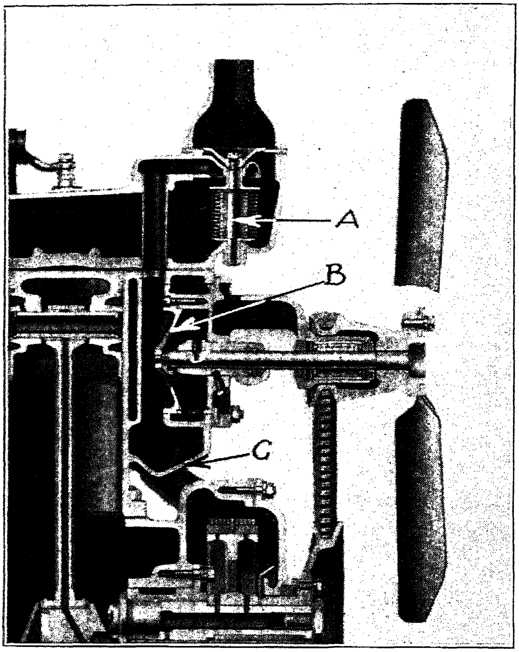


Fig. 6. Fan, Fan Mounting, Water Pump, Thermostat, Water Jackets, and Other Features of the Packard Cooling System

The thermostat shown at *A* in the section of the Packard Motor, Fig. 6, is so designed that it is closed until the water within the engine reaches a satisfactory operating temperature. In order to facilitate the action of the pump and that portion of the cooling solution within the water jacket of the engine, by-passes are made use of so that the water is merely circulated about within the engine jackets and does not pass forward to the radiator until such time as the temperature of this water is sufficient to open the thermostat. Naturally the thermostat will open rather slowly since the instant it starts to open, cold water is drawn from the radiator and quickly comes in contact with it, thus tending to close it again.

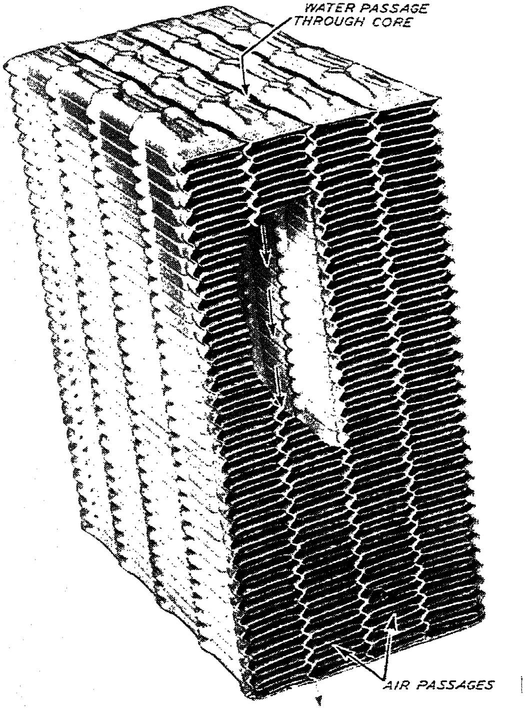


Fig. 7. Cadillac Cellular Radiator Core Section
Courtesy of Cadillac Motor Car Company

It will be seen that the use of the thermostat will allow the engine to warm up much more quickly than if the entire amount of water within the cooling system was circulated as soon as the engine started operating. This is a very desirable feature, since the crank-case dilution and fuel economy are both involved. This satisfactory engine temperature also allows more prompt operation of the car in a satisfactory manner. This is especially the case when the heavy fuels, now in general use, are considered.

Radiators. Formerly the radiator was made as one unit, that is, the outer surface of the radiator was exposed and became a part of the design of the car. This practice has long since been superseded by the one of constructing the radiator assembly in two parts. The radiator grille is designed to blend in with the general design of the car and may take any form necessary to gain this end. It is usually made of a metal which will lend itself to plating, either nickel or chromium. The part which does the real work of cooling, however, is more properly termed the radiator and while built up of many parts is usually soldered into one unit. In some cases, however, a jacket which is designed to serve as the mounting unit is clamped on to the radiator core.

Cadillac Radiator Core. A section of the radiator core used in all of the current Cadillac models is shown in Fig. 7. It will be noted that the water passages, as indicated by the arrows, are straight and provided with smooth interior, permitting free flow of the water and facilitating the cleaning of the radiator. The fins, which are mounted between the vertical water passages, are of the full bonded construction. Louvers are cut into the fins so as to increase the heat dissipating capacity of the radiator core as the air is drawn or forced through the cooling fin, past the water cells. The material used in the radiator core is all copper.

Round-Tube Radiator Core. The round-tube radiator core was long popular and is representative of the earliest practice. In this case copper or brass tubes are set between upper and lower tanks and in order to facilitate cooling, thin copper fins are assembled upon the tubes at regular spaces. The section of the core shown in Fig. 8 is a full size view of this type of equipment. In order to secure proper cooling, it is quite essential that the thin copper fins be sweated on to the tubes so that the inner core is an integral mass. At one time radiators were built without making use of this method of sweating the parts together, with the result that it was impossible to cool the car.

The simple construction embodied in the style shown in Fig. 8

is substantial and effective. It lends itself to repairs and there is less likelihood of the radiator becoming stopped up since the water passages through the tubes are large.

Pressure Type Radiator Cap. A number of automobiles are making use of pressure operated vent and overflow caps. These caps are provided with a vent valve and a vacuum valve. The pressure operated vent valve is contained in the radiator filler cap. Fluid must pass through this valve in order to reach the overflow pipe. It requires a pressure of about four pounds to open the valve. Owing to this fact, there is less chance of the loss of cooling solution, particularly when the rather volatile anti-freezes are used.

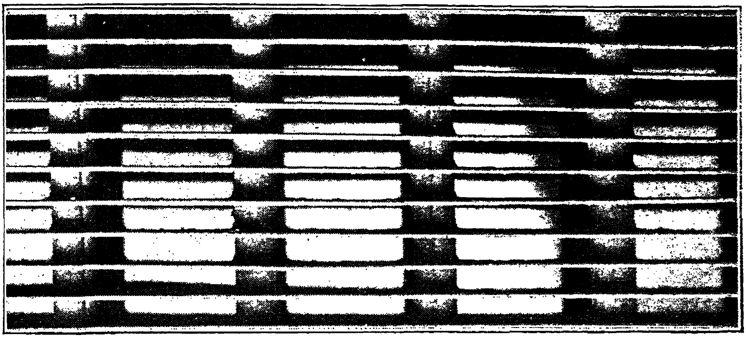


Fig. 8. Section of a Round-Tube Radiator Core

These pressure caps are also valuable in retaining the cooling solution when driving in high altitudes as is the case in mountain driving. At sea level water boils at a temperature of 212 degrees. As the car is driven to higher altitudes, pressure of the air on the water in the system is normally reduced. To offset this pressure reduction and keep the water in the cooling system under a normal or a bit above normal pressure, these caps have been devised. As the pressure of the water within the system comes up to one in excess of four pounds, the vent valve is forced open against the spring which holds it closed normally and excess pressure is relieved through the overflow pipe.

Care must be exercised in removing these caps as there is danger of being seriously burned when the fluid within the cooling system has come to a vaporizing point. If the fluid is boiling vigorously, it can be heard. When removing the cap from a hot engine, the best plan is to unscrew the cap only part way at first in order to vent the system through the overflow. Steam issuing from the overflow pipe will be evidence that this has occurred. Hold the valve in this partially opened position until there is no more steam blowing after which the cap can be completely removed. In the case of an engine which is cool or operating at normal temperature, the cap

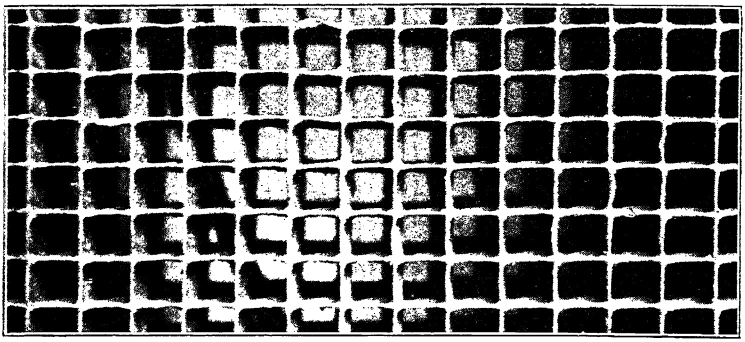


Fig. 9. Section of a Square Honeycomb Radiator Core

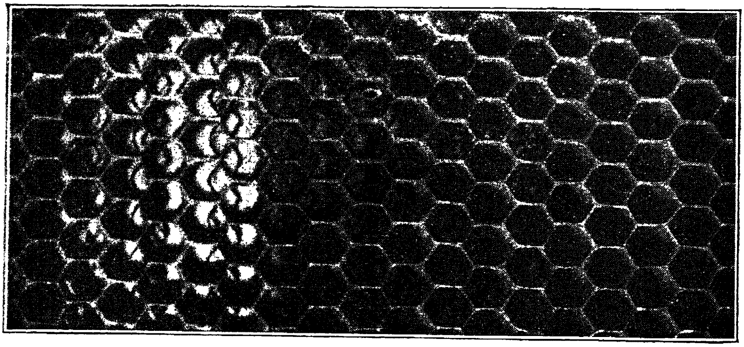


Fig. 10. Section of a Honeycomb Radiator

may be removed without any danger. To secure the full advantage of this type of cap, it is necessary that it be screwed tight when in use.

Square Honeycomb Core. The square honeycomb is illustrated in Fig. 9. This type of construction makes use of a larger number of tubes which run from the front of the radiator to the rear, the ends being soldered together. When this construction is used, water, which leaves the upper tank, may flow in practically any direction as it is cooled and passes downward. By this is meant that it is not necessary for the water to flow directly down since it may go completely around one of the honeycomb or small tubes.

Honeycomb Radiator. A section of the conventional type of the honeycomb radiator is shown in Fig. 10. This may be of the general type of construction just described, with reference to the square honeycomb tubes or may approximate more closely the use of tubes such as was described with reference to the flat tubes. The honeycomb effect is sometimes secured directly by the use of tubes or by the application of a large number of very fine fins. These fine copper fins are sweated on to the tubes or cells and become a very definite part of the core, serving as conductors of heat to dissipate it into the core.

Cross-Flow Radiator. In practically all cases the radiator makes use of the vertical tube rather than the horizontal tube. The Pontiac cross-flow radiators, used up to 1935, made use of a novel principle, illustrated in Fig. 11. Water which has been heated within the jackets of the engine flows off through the tube *4* in the lower figure. It enters the tube or a similar one at *14* in the upper left-hand illustration. The water which enters at this point comes in contact with other water which is above it. As the water within the radiator is cooled, it does not pass downward but instead is drawn across through the horizontal tubes, as shown in these several figures. While it is flowing across the radiator, it is being cooled and it will then settle in the side tank and be withdrawn from the side tank at *10*. This type of radiator construction does away with a certain amount of loss of water, owing to vaporization. In all cases of water-cooled engine, no matter what the temperature, there is a certain amount of vapor within the upper portion of the upper radiator tank. This vapor is free to escape through the vent tube.

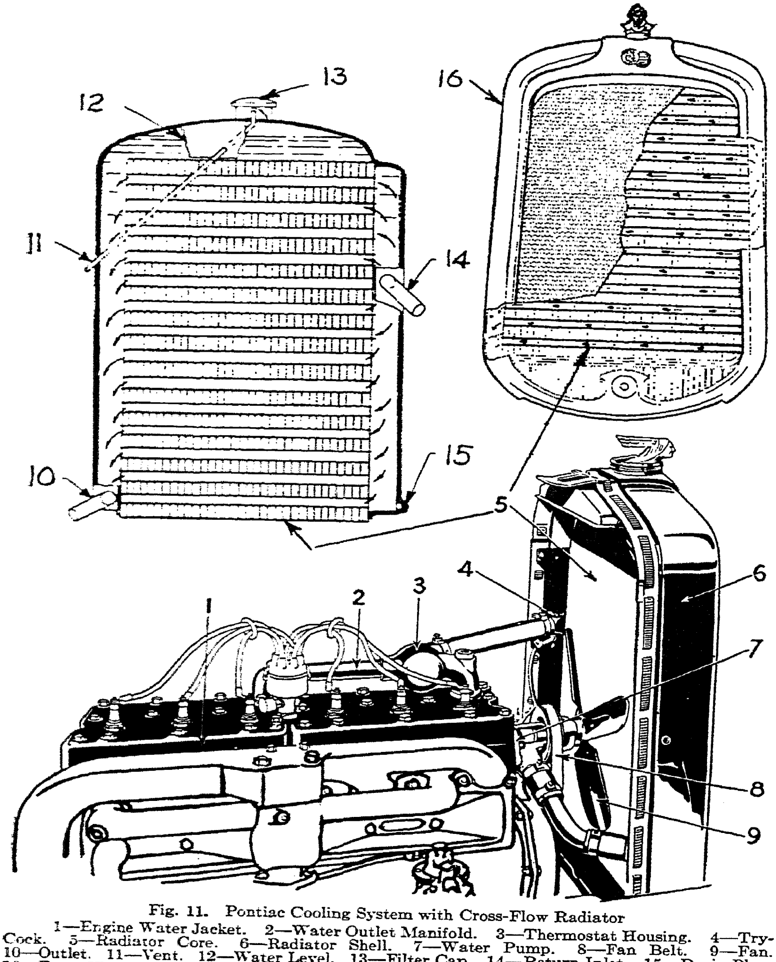


Fig. 11. Pontiac Cooling System with Cross-Flow Radiator

1—Engine Water Jacket. 2—Water Outlet Manifold. 3—Thermostat Housing. 4—Try-Cock. 5—Radiator Core. 6—Radiator Shell. 7—Water Pump. 8—Fan Belt. 9—Fan. 10—Outlet. 11—Vent. 12—Water Level. 13—Filter Cap. 14—Return Inlet. 15—Drain Plug. 16—Front View Partially Sectioned.

Water Pumps. The centrifugal type is of standard design and is illustrated in Fig. 12, as used on Graham "8." At the lower part of the pump are to be found the pet cocks. In all water-cooling systems, a pet cock or pet cocks are provided at low points so that when draining, the entire amount of water may be withdrawn. When draining a cooling system, especially if draining to prevent freezing, it is always well to operate the engine for a time in order to have the pump draw out or free any water which might have been pocketed. This will prevent the freezing of the pump and possibly breakage of parts when attempting to start the engine.

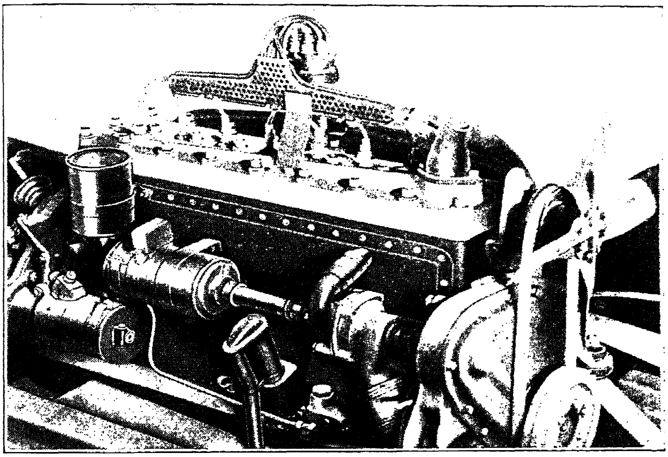


Fig. 12. Centrifugal Water Pump on Graham "S"

Hudson and Terraplane Water Pump. Fig. 13 illustrates the 1935 Hudson and Terraplane six-vane centrifugal type pump. The pump shaft is mounted on needle bearings, these being used in order to cut down the amount of power required to drive the pump and to insure against overheating and burning out of the pump-shaft bearing through lack of proper lubrication.

Owners who care for the lubrication of their cars are prone to overlook the lubrication of the pump shaft. Student mechanics likewise need to be careful that this point is not overlooked. Each year many pump shafts are replaced owing to the lack of thought being given to the proper care of this unit. Results of this type of neglect apply equally to all makes of cars.

Ordinary cup grease is not satisfactory for water pump shaft lubrication since it is easily affected by contact with water and tends to lose its lubricating qualities. Manufacturers of the better grades of lubricants have developed special greases for this type of service. Different products are sold under different trade names but the service man is safe if he uses those lubricants which have been especially prepared for this type of service.

Packing a water pump shaft may seem relatively simple to the average mechanic but a pump shaft may easily be ruined by an inexperienced workman using a defective packing and unreasonable force on the packing nut and gland. Sometimes the pump shaft is deeply scored by undue pressure on dried out and hardened packing. The packing should be removed, if dry and hard, and new packing installed. This may be either of the plastic or ring type.

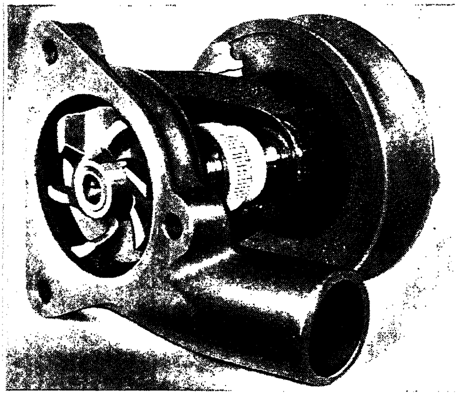


Fig. 13. Six-Vane Water Pump Mounted on Needle Bearing, Used in 1935 Hudsons and Terraplanes

Buick Pump and Fan Assembly. The 1937 Buick equipment for both the Series 40 and the larger cars is illustrated in Fig. 14. In all cases, the water pump and fan assembly is mounted on the front end of the cylinder block. The pump is of the centrifugal type and is driven from a pulley on the crankshaft by means of a V-belt. The Series 40 pump is run at 1.3 times engine speed, while the Series 60 - 80 - 90 pump is driven at 1.1 times engine speed. The pump shaft is case hardened and is supported in the pump body by two oil retaining bushings. The lubrication of these bushings is from the oil reservoir which is cast into the pump body and which should be filled with 10-W oil each 1000 miles of service. It is important

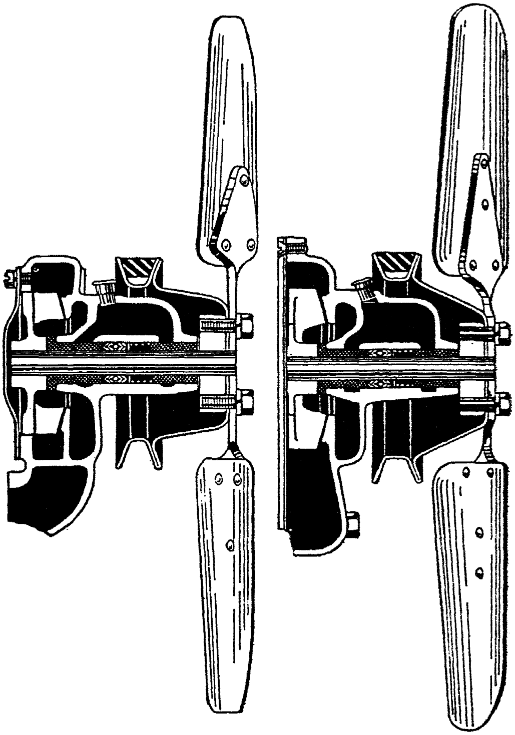


Fig. 14. Buick Water Pump and Fan Assembly
Courtesy of Buick Motor Company

that heavier lubricants are not used in the oil reservoir, as this heavy oil will interfere with the normal oil feed through the bushings. The water pump packing is the self-adjusting type and is lubricated through the pump bushing by the lubricant installed during the assembly. If either pump bushing is removed for any reason, it will be necessary to replace both bushings and the packing assembly when reassembling the pump.

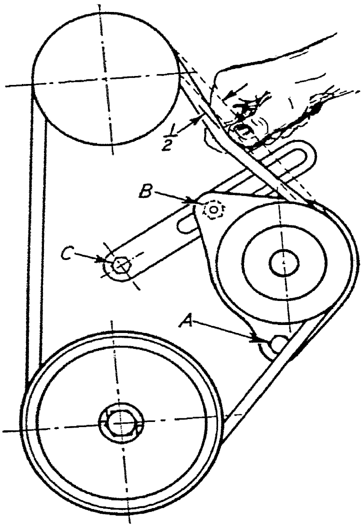


Fig. 15. Buick Fan Belt Adjustment

Buick Fan Belt. A V-type belt, illustrated in Fig. 15, is used as the water pump fan and generator from a pulley attached to the front end of the crankshaft. It is necessary that the belt be adjusted so that it will deflect approximately ½ inch, as shown in Fig. 15. Only a light pressure should be required to secure this deflection. If the belt is too loose, it will slip and wear excessively. The loose belt may also cause a noise similar to a spark rap at high speed. If the fan belt is too tight, the generator and pump shaft bearings will wear rapidly. The Series 40 fan belt is 25/32 inch wide and the Series 60 - 80 - 90 fan belt is 29/32 inch wide.

When adjusting the fan belt, first loosen the lower and upper generator clamp bolts shown at *A*, *B*, and *C*, Fig. 15, a slight amount. Next, adjust the fan belt tensions to ½ inch, as shown, securing this deflection between the generator and fan pulleys. Next, retighten the upper clamp bolts *B* and recheck for tension. Finally clamp bolts *A*, front and rear, and *C*.

Buick Thermostat. The circulation of the cooling fluid within the cooling system of the Buick engine is illustrated in Figs. 16 and 17. The flow of the cooling solution is thermostatically controlled, the by-pass type of water temperature control being used. This system permits the water pump to circulate the coolant to the engine during the warm-up period without passing through the radiator, thus allowing the engine to reach its normal operating temperature quickly. This recirculation is illustrated in Fig. 16 where it will be noted that the thermostat permitting water to circulate to the radiator is closed and the water merely leaves the top of the cylinder block and is forced back into the lower portions of the cylinder block water passages. This control is accomplished by means of a thermostat which is located in the passage of the

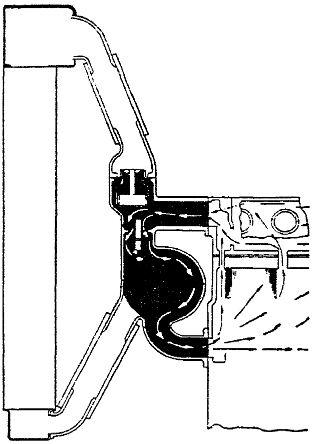


Fig. 16. Buick Cooling System Recirculation

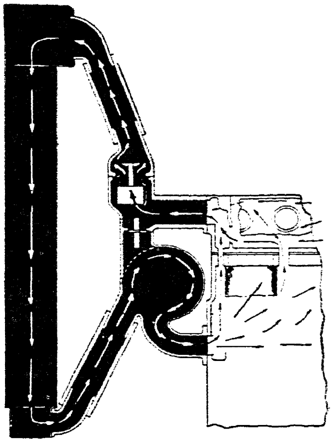


Fig. 17. Normal Circulation in Buick Cooling System

Courtesy of Buick Motor Company

cylinder head water-outlet and its spring loaded valve located in the water passage between the cylinder head water outlet and the water pump inlet, as shown in Figs. 16 and 17.

The spring loaded valve is somewhat smaller than the neck where it is located and this allows of a fixed orifice. The total area of the orifice is equivalent to a ½-inch hole and permits a thermosiphon circulating when the engine is not running, cutting down the effect of what is termed "after-boil." "After-boil" refers to the stagnating of the coolant in a hot engine when the pump is not circulating the solution. During the time that the coolant is below normal operating temperature and the engine is running, it is blocked from circulating through the radiator by the thermostat valve. The pump pressure forces the coolant through the by-pass valve and allows the coolant to recirculate through the cylinder block and head, as shown in Fig. 16. When the coolant has reached a temperature of 148 to 153 degrees, the thermostat valve starts to open and the circulation proceeds in the normal way. At approximately 170 degrees the thermostat is fully open, relieving the water pump pressure on the by-pass valve which automatically closes.

Testing the Thermostat. In order to test a thermostat for correct operating temperature, it should be immersed together with a thermometer in a container of water. Agitate the water to insure both water and thermostat being at a uniform temperature. When heating the water, do not allow the thermostat or thermometer to rest on the bottom of the container, as this will cause the thermostat or thermometer to be at a higher temperature than the true temperature of the water. When reaching a temperature of 148 to 153 degrees, the Buick valve should start to leave the seat and be fully open at a temperature not to exceed 175 degrees. This is important as a thermostat which was holding closed, or a sticking by-pass valve either, opened or closed, will prevent the cooling system from functioning and cause overheating.

Radiator Shutters. A great many cars were provided with radiator shutters, which were designed to enhance the operating characteristics of the car. Some of these are manually controlled and some of them thermostatically controlled. The idea of the shutter is to prevent the cold air striking the radiator core until such time as the temperature of the engine has reached a satisfactory point for economical operation. As the bellows, Fig. 18, absorbs heat from the cooling solution, it expands and forces the bell crank to operate, with the result that the spring tension is overcome and the vertical shutters are opened. The greater the amount of heat, up to a certain predetermined point, the wider the opening of the shutters. When the engine cools, the shutters close. The use of this device proves economical. Not only is fuel saved, but crankcase dilution is decreased. This, of course, lengthens the life of the engine. The shutters may be in front of the radiator grille or between it and the radiator core.

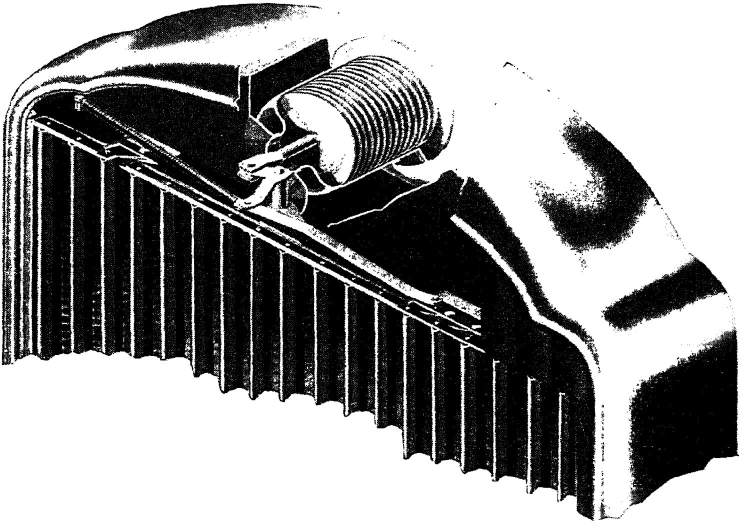


Fig. 18. Buick Thermostatically-Controlled Vertical Radiator Shutters

Cooling-System Service. Cooling systems are efficient only so long as they are free from foreign materials such as, rust, lime, or other elements which might be held in suspension in the water and then deposited in the radiator tubes or cells. The length of time required for a radiator to clog will vary according to the condition under which it is used, for instance, if the water in the community in which the car is in service is filled with lime or other foreign elements, the sediment will settle or collect within the tubes rather rapidly.

Handling the Radiator. Many repair men experience trouble with radiators which to all intents and purposes come about when the car is in the garage for service. This is usually due to the fact that when the radiator is removed from the car after a job such as valve grinding and carbon removing, it is set aside and allowed to dry out. In certain cars this is a condition to be looked for and avoided by seeing that the radiator is properly flushed before it is set aside, or else the radiator should be kept filled with water. Rust, lime, or scale are usually causes for the radiator clogging.

Boiling Out a Radiator with Sal Soda. Cars which have been in service for a while are likely to be in need of having the radiator cooling system boiled out so as to clean the radiator and secure efficient cooling. This is a situation which might arise at any time, but a good time to give it attention is when the cooling system is being serviced for the winter months, and then again in the spring when the car is being serviced for summer driving.

First start the engine and operate it until the water has come up to a normal operating temperature, then open the petcock and drain off the water. Prepare a solution of sal soda—one pound soda to five gallons of water; next fill the cooling system with this solution, after which the engine should be started and operated until the solution has come to approximately the boiling point. Run the engine with the solution in the cooling system for a short time, stop the engine, allow it to set for a few minutes, then drain off the cleansing solution. Flush the system with clean water so as to remove any trace of the cleansing solution.

Sal soda, which is the common washing soda, is a caustic solution and will destroy any paint it comes in contact with. For this reason it is very necessary that **extreme care be used to see that none of the cleansing solution comes into contact with the paint or finished parts about the hood of the car.** Keep the radiator cap on tight while boiling out the system.

Flushing a Normal Cooling System. When servicing the cooling system of a car which has shown any tendency of overheating, all that is necessary is to flush the system as shown in Fig. 19. It will be noted in this case that any petcocks such as those in the radiator

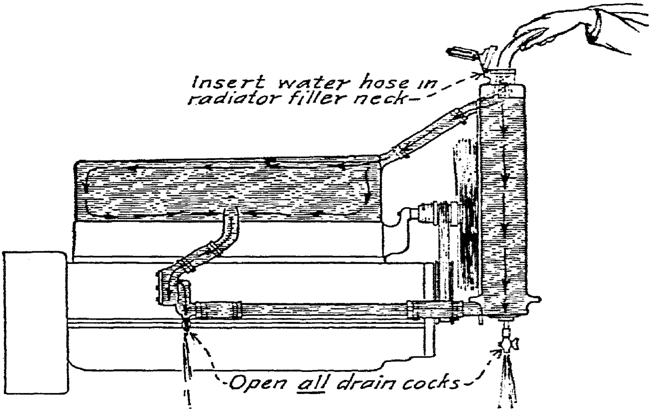


Fig. 19. Ordinary Method of Flushing the Cooling System

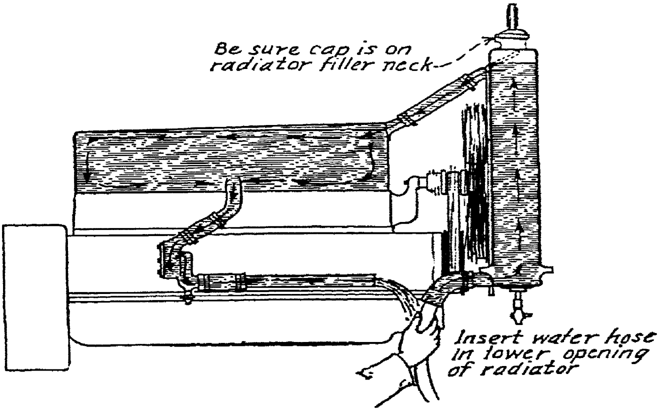

Be sure cap is on radiator filler neck
Insert water hose in lower opening of radiator

Fig. 20. Flushing the Cooling System from the Bottom of the Radiator to Remove Rust and Scale

or pump are open. The water hose is inserted in the top of the radiator. Water flows down through the system and washes out any small amount of sediment or rust.

Flushing a Rust-Clogged Radiator. This work is done as shown in the illustration in Fig. 20, where it will be noted that the hose connection has been removed from the lower gooseneck or hose connection. The cleaning water now flows from the bottom of the radiator up through the radiator and then through the water jacket, and finally through the pump, and is wasted from the end of the hose which is removed. It will be noted that this causes the water to flow through the cooling system in the direction the reverse of the normal one and thus serves to break up some of the scale and rust deposited.

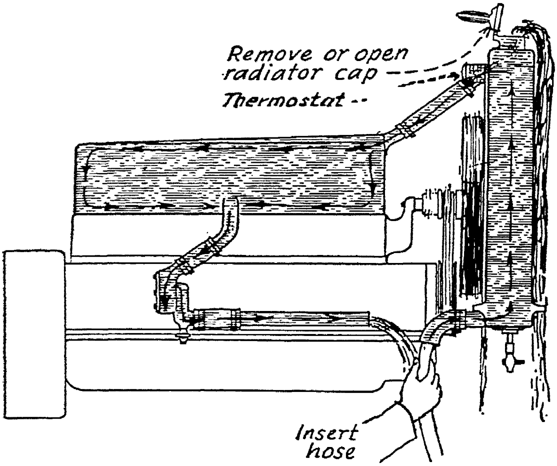


Fig. 21. Flushing a Rust- and Scale-Clogged Cooling Which Is Fitted with a Thermostat

Flushing a System with a Thermostat. The thermostat may be in the upper line or hose connection as shown in Fig. 21. The thermostat is open only when the temperature of the cooling system reaches a certain predetermined point. If cold water is used for flushing, it will not cause the thermostat to open, with the result that one or two things must be done. Possibly the best plan is to allow the radiator cap to remain open and flush from the bottom up to remove the sediment accumulated in the radiator. If hot water is used, the radiator cap may be left open, but the action of the hot water will cause the thermostat to open so that more of the hot water will flow through the water jacket and water pump. Another method of flushing the block is to use the cold water and open up the top hose so that the water may be introduced, as shown in Fig. 22.

Using Air and Water as a Flushing Combination. A small amount of air under pressure may be introduced into the water which is used for flushing the cooling system. The pressure of the air must not exceed 10 or 15 pounds, since the radiator core will not stand any heavy pressure. When the air jet is used in connection with the water, an air nozzle is set into the lower hose, along with the water hose. If considerable radiator flushing is being done, the workman should provide himself with a combination nozzle.

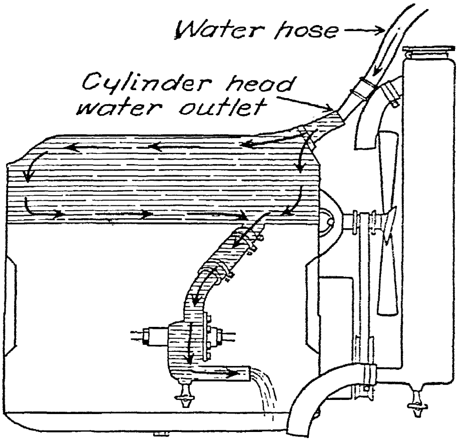


Fig. 22. Flushing Out the Water Jackets of the Cylinder Block

The advantage of using the air lies in the fact that water and air combined, when sent through the radiator in spurts, has a mu
greater loosening and cleansing effect. Accordingly, when this co

bination is used, the water is allowed to flow for a short time, and then the air is introduced for a short time with it, and then closed off. Spurts of air are used rather than a steady flow.

NOTE: In the large centers there are radiator cleaning establishments. These are in connection with repair stations. They make use of special compounds when boiling out radiators. The nature of these compounds may be learned by getting in touch with local distributing agencies or automotive jobbers.

Tightening the Cooling Systems. The loss of a small amount of water is usually of slight concern to the car owner. On the other hand, when a car is serviced with an anti-freeze, some of which are very expensive, the customer is very anxious to know that the solution which he pays for is going to stay in the cooling system. Some of these solutions are harder to hold in the cooling system than water. Fig. 23 illustrates the points which require attention when tightening up the cooling system. These are the cylinder head bolts, expansion plate screws, the hose bands, petcocks, and the water pump bushings.

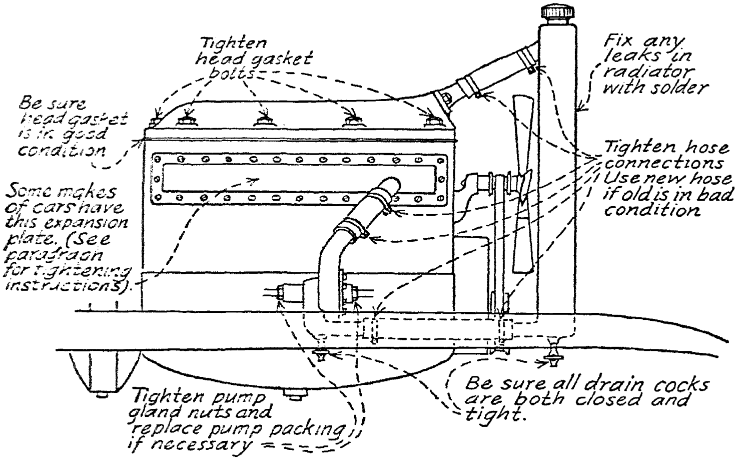

Tighten head gasket bolts
Be sure head gasket is in good condition
Some makes of cars have this expansion plate. (See paragraph for tightening instructions).
Fix any leaks in radiator with solder
Tighten hose connections Use new hose if old is in bad condition
Be sure all drain cocks are both closed and tight.
Tighten pump gland nuts and replace pump packing if necessary

Fig. 23. Service Chart Illustrating Parts of a Cooling System Requiring Tightening and Servicing for Anti-Freeze

Radiator-Hose Troubles. Fig. 24 illustrates the most ordinary type of radiator-hose failure. The two hose sections shown at the lower part of the illustration have been photographed from the end. It will be noted that the one at the left has had the inner lining curled until the passage is almost entirely clogged. The one at the lower right is not in such an advanced stage of deterioration. The view at the top is of the same hose as the one at the lower right. When hose connections are in such condition, the cooling solution is almost blocked and overheating is certain.

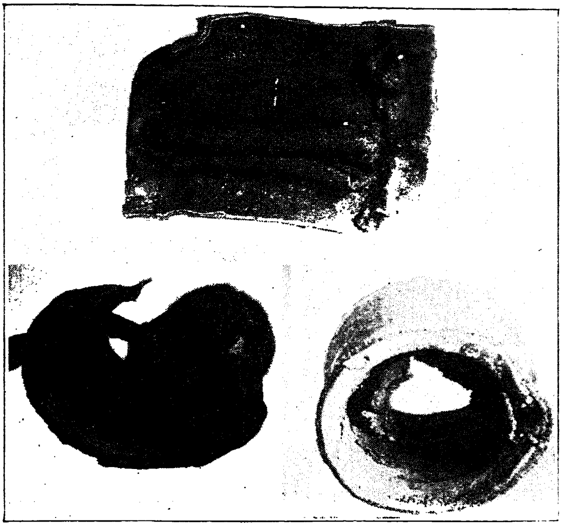


Fig. 24. Radiator Hose in This Condition Will Cause Overheating

The most troublesome point about a cooling system is with the hose band and hose-end connection, where leaks are prone to develop. While this is a small matter, it may result in serious damage if the owner is not aware of it. The service man should use care to see that these small leaks are stopped. When long connections are used between the radiator and the pump, they should be supported to prevent their collapsing when the engine is under speed. These connections are the ones at the lower part of the power plant and very frequently are almost out of sight. The best practice is to make use of a section of steel or copper tubing and two short lengths of hose if there is considerable distance between the pump and the radiator. This is not always done, however, and the suction of the pump on the hose will cause it to flatten out or collapse, especially if the radiator has become partly clogged. Once it collapses, no portion of the water can get through and serious overheating results. When the mechanic looks for the trouble, the engine may be stopped or idling and the hose will have assumed its normal condition, all of which makes it hard to locate the trouble which may not be suspected. An easy cure for trouble of this kind when found is to place a coil spring, such as a valve spring, within the hose to prevent it collapsing.

The effects of anti-freeze on hoses may result in a condition similar to that shown in Fig. 24. Most anti-freezes are not detrimental to hose connections; however, any of the anti-freezes will have a certain effect in hastening deterioration. Oil within the radiator will cause the hose lining to become softened and rot, which will result in the curling.

Cooling systems are serviced in the fall when the anti-freeze is added and again when the anti-freeze is removed. It is a good plan to sell your customers on the idea that it pays to have the hose connections renewed at these intervals and no trouble is likely to develop in the meantime.

Servicing a Water Pump. The packing glands on the sides of the water pump may be provided with means for lubricating or not. When they are so provided, the grease cup should be kept filled with a high grade of graphite or other grease suitable for use in such work. When no grease cup or alemite fitting is provided, it is assumed that the packing will have graphite in it which will be sufficient for the life of the packing. This is not always the case and leaking may result even though the packing nut is drawn up from time to time. A good plan is to remove the old packing and replace it with new.

Packing comes in two forms—the most usual being the roll of packing cord, properly graphited, which may be purchased from the jobber and should always be on the shelf of the service station stockroom. Another form, which is more satisfactory when it can be obtained, is the packing ring. These are made in sizes corresponding to the engineering specifications for the popular cars. They are provided with a bevel split so they may be twisted apart, slipped over the shaft, and installed within the packing gland under the nut.

The most serious mechanical failure which is common to water pumps is that of the pitting and scoring of the pump shaft where the pump packing has been compressed on it. The corrosive effects of the water and the scoring of the packing result in rapid wear. In many instances this occurs where no grease cup has been provided or where the greasing has been neglected. The best remedy is to have the pump shaft removed and replaced with a new one. The customer is not always willing to meet this expense. In such cases, the following treatment is recommended for the rough and pitted shaft.

Plastic Packing. Where the pump shaft has been scored and pitted so badly that it is impossible to keep the packing tight, the use of a plastic packing is recommended. These may be secured through the automotive jobber. The trade name of one of these is "Konaugh." This is a composition packing which may be pressed into the pump gland housing with the thumb and forefinger or by means of a small tool. When using this, it should be inserted and then the gland nut pulled up quite tight and the engine operated or the car driven for a few miles, after which the gland nut may be taken up again to compensate for the filling of the grooves by the plastic packing. After the above treatment, be sure to lubricate the job with a proper grade of grease. Owing to the heat surrounding the pump, the ordinary chassis lubricating grease is readily dissolved and carried away. Possibly the best grease is the tallow base grease or some of the specially prepared greases, which may be secured through the supply houses.

Loose or Worn Impellers. The impellers which are used in the centrifugal type pumps on the side of the engine are usually larger than those mounted within the cylinder block at the upper front and driven from the fan pulley. The latter is more likely to fail, due to end thrust, which causes the flanges of the impeller to be worn off to a point where no pump action is secured.

One of the most common causes of failure is freezing, resulting in sheared keys and broken pins, which allow the pump impeller to loosen on the pump shaft. This condition is one of the reasons that manufacturers are using flexible means for driving the pump shafts, such as the fan-belt drive. Many cases of broken timing gears are reported each year, owing to the fact that the water pump has frozen and the starting motor is used in an attempt to start the engine. When overheating is experienced, the pump impeller is always to be suspected. It may be necessary to disassemble the job to make sure that it is in proper condition.

Overheating Causes. The causes of overheating have already been treated and will simply be enumerated here. The most common ones are dirt, rust, or scale, which accumulates in the radiator, oil which has entered the cooling system, hose failure, failure of the thermostat, usually due to loss of liquid within it, loose fan belts, broken fan belts, dry fan-shaft bearings, low water supply, use of anti-freeze in the hot months, faulty water pump, dirt and insects in the air passages of the radiator core, an overloaded car, and brakes which are set or dragging.

COMPARATIVE TABLES OF DENATURED ALCOHOL AND DISTILLED GLYCERINE

Loss of Anti-Freeze Properties

Per Cent by Volume	Glycerine Boiling Point Degrees F.	Per Cent Glycerine in Vapors	Alcohol Boiling Point	Per Cent Alcohol by Weight in Vapors
10	214	0	199	49
20	216	0	190	64
30	217	0	187	71
40	221	0	183	76
50	225	0	181	80

PREPARING ALCOHOL OR GLYCERINE ANTI-FREEZE

Per Cent by Volume of Alcohol or Glycerine Solution

Where the Lowest Temperature to be Expected Is	Use a Solution of the Following Per Cent by Volume
20° above zero	15
10° above zero	25
0° zero temperatures	35
10° below zero	40
20° below zero	45
30° below zero	50

Anti-Freeze. The three most popular anti-freeze solutions are —denatured alcohol, radiator glycerine and Eveready Prestone. Each has its own peculiar advantages. It is not within the province of this treatise to rate one as superior to another, rather to set forth the advantages of each so as to allow the student mechanic to present the relative merits to his customers. No one knows what the developments of the next season may be.

Alcohol. Alcohol is the cheapest of the three in point of initial cost. It is an excellent anti-freeze, mixes readily with water, remains in suspension, and is to be had at all points. Its disadvantage lies in the fact that it will boil away readily and also in the fact that it will affect the finish of the car if it comes in contact with it.

Radiator Glycerine. This is a form of alcohol and is quite similar to the glycerine of household use. It is produced by distilling crude glycerine and condensing the glycerine vapors. It has a boiling point which is quite high. When mixed with water, it has a higher boiling point than the water itself, as will be noted from the study of the comparative table shown herewith—comparing the relative loss of the denatured alcohol and distilled glycerine at various boiling points and in certain percentage of volume.

Eveready Prestone. Eveready Prestone is a trademark for a colorless, odorless liquid which is used in the preparation of anti-freeze solutions. It is a distinct chemical compound and as it comes to the service station is undiluted with water. Some points claimed for it are the following: When used in the percentages recommended for preparing the solution, it will give protection against freezing. It does not boil away, having a higher evaporating point than that of water. It will not affect any of the parts of the cooling system and it has a satisfactory heat coefficient so that the motor will not overheat. It is claimed that it does not affect the car finish and is not inflammable. Perhaps the only objection to it is the initial cost, which is high.

Servicing a Car with Alcohol. Prepare the cooling system by having it drained, flushed, tightened, and going through the steps an inspection of the cooling system may indicate need of. Determine the capacity of the cooling system by inspecting a chart which will be furnished by the automotive jobber or the distributing agency which furnishes the alcohol. Determine the point to which the car is to be protected, as near as possible. Drain off sufficient water so that the amount of alcohol to be added may be added without causing the radiator to be filled. Finally fill the radiator with water to a point two or three inches below the top of the upper tank, Fig. 25. If no other chart is at hand, the following one will serve as a guide. It must be remembered that while a small amount of alcohol will prevent solidifying of the solution, ice crystals will appear at a much higher point.

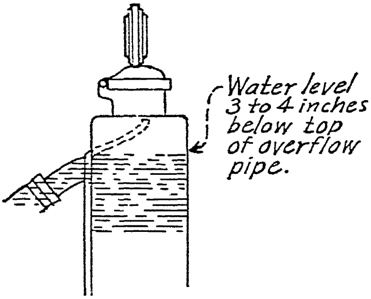


Fig. 25. Keep the Liquid Level in the Radiator 3 to 4 Inches Below Top of Overflow Pipe

FREEZING POINTS OF ALCOHOL AND WATER SOLUTIONS

Per Cent Alcohol by Volume	First Crystals Appear at
10	27° above zero
20	19° above zero
30	10° above zero
40	2° below zero
50	18° below zero

FREEZING POINTS OF GLYCERINE AND WATER SOLUTION

Per Cent Distilled Glycerine by Volume	First Crystals Appear at
10	29° above zero
20	21° above zero
30	12° above zero
40	0° at zero
50	15° below zero

Servicing a Car with Radiator Glycerine. Prepare the system, being very careful to see that all joints are secure and tight. Radiator glycerine has the so-called habit of creeping, that is, it will follow along any joint and, unless the cooling system has been most carefully serviced, it may find its way through a joint. There is no particular objection to this except for the fact that the radiator or the joint at which it appears will seem to be leaking all the time. As a matter of fact, very little solution is being lost; but since the radiator glycerine does not evaporate, it seems that the leak is more serious. The chart on page 32 shows the percentage by volume of distilled glycerine to use in order to secure protection to certain temperatures. For instance, the first crystals will appear in the glycerine and water solution when the temperature has fallen to zero in the case of a solution of 40 per cent glycerine and 60 per cent water. Since glycerine is not boiled away, a larger percentage may be used when servicing the car for the winter. In fact, if everything is tight, there is no need for continually adding glycerine to the solution since the glycerine is not boiled away. Glycerine radiator solutions as put on the market may be already diluted with some water.

AMOUNT OF EVEREADY PRESTONE TO USE FOR PROTECTION TO TEMPERATURES INDICATED

(In Gallons)

Capacity of Cooling System	10 Degrees above Zero	Zero	10 Degrees below Zero	20 Degrees below Zero	30 Degrees below Zero
2	½	...	...	...	1
2½	...	...	1	...	1½
3	...	1	...	...	1½
3½	1	...	...	1½	2
4	1	...	1½	...	2
4½	...	1½	...	2	2½
5	1½	...	2	...	2½
5½	1½	2	...	2½	3
6	1½	2	2½	...	3
6½	2	...	2½	3	3½
7	2	2½	...	3	3½
7½	2	2½	3	3½	4
8	2	2½	3	3½	4
8½	2½	3	3½	4	4½
9	2½	3	3½	4	4½
9½	2½	3	4	...	5
10	2½	3½	4	4½	5

Servicing a Car with Eveready Prestone. As in the case of the glycerine, the Eveready Prestone does not require more than one servicing for the season. For this reason, make very certain that all parts of the system are tight and are kept tight. The solution is expensive, but when considered over a season the cost is warranted. It is unwarranted if the customer has to replace the Prestone owing to a defective job of servicing. As in the case of the glycerine, the boiling point is high and if any solution is lost outside of actually being spilled or leaking from the system, it is the water rather than the Prestone, and only water need to be added. The chart on page 33 shows the amount of Prestone to be added to a cooling system in order to secure protection. Since the solution is sold only by gallons and half-gallons, smaller amounts are not considered in making up the chart and in some cases the protection will run lower than that of 30° below zero. Fill the cooling system to 3 inches from the top of the overflow pipe. This allows for expansion of the solution without loss.

Testing the Strength of the Anti-Freeze Solution. Hydrometers, Fig. 26, are supplied to test the density of any of the three popular anti-freezes. These are very similar to those used for testing batteries. The workman doing the job should make certain that he understands exactly how to read the tester. Not all makes are read the same. The storage battery specific gravity hydrometer may be used for testing the distilled glycerine solution. The reading will be according to the following chart:

If the solution is hot 160° F Specific Gravity will be	PROTECTION TO	If the solution is cold 32° F. Specific Gravity will be
1.063	+10° F.	1.094
1.0835	0° F.	1.1175
1.1015	−10° F.	1.137
1.114	−20° F.	1.152

Watch Radiators and Heat Indicators in Winter. In order to prevent the loss of any of the cooling solution in the winter, customers should be instructed to give particular care to the temperature of the cooling solution and not allow it to exceed that which will prevent the boiling away of the water in the case of the glycerine or Prestone solutions or the boiling away of the alcohol in the case of its use as an anti-freeze. Alcohol will boil away at a temperature as low as 180°, water of course, at 212° F. It sometimes happens that the automatic radiator fronts fail. This is likely to be the case where the front has been stored during the summer and is again installed as the customer's car is serviced for the winter. The chemical solution within the thermostat bellows may have become lost and no action will result as the job is heated. This may happen at any time in the life of the shutter.

Danger of Driving without Anti-Freeze. Since many cars are equipped with thermostats, it is essential that customers be educated to the fact that it is a dangerous practice to drive a car in the cold winter months without some form of anti-freeze. Formerly the practice was indulged in by many motorists to drain their cars in the evening. Even that has long since proved poor economy since, in many cases, the owner who thought he had drained his car found that water had pocketed at some point and a bursted cylinder or valve port was the result. This practice is even worse when the car is equipped with a thermostat. At *A*, Fig. 27, it will be noticed that the thermostat which is built into the radiator and water line, is closed and at *B* it is open. These thermostats are so designed that they will not open until the temperature of the water

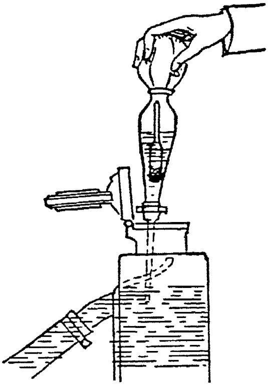


Fig. 26. Anti-Freeze Solution Should Be Tested Weekly

has reached approximately 120°. Up to this point circulation through the radiator is prevented.

Tighten the Fan Belt. For many years the flat fan belt was used in the majority of cases. The fan mounting was so designed that by loosening a clamp screw the fan pulley assembly could be swung upward and thus the fan tightened. With the advent of the practice of building the fan and water pump in a unit assembly, it was found necessary to devise other means of tightening the belt, which in most cases is of the "V" type.

The "V"-type belt and pulley has an inherent advantage in that the greater the strain on the belt, the more closely and tightly the belt will be pulled into the pulley groove. On the other hand, the belt might become so loose that no action will result. In many cases the tightening is affected by means of a split fan-belt pulley. By loosening several screws, a portion of the pulley may be turned sideways and a cam or eccentric action secured which throws the two halves of the pulley closer together, resulting in a tightening of the fan belt, owing to the fact that the size of the pulley is increased. In other cases the "V"-type fan belt is tightened by means of a generator adjustment, as is the case with the Chevrolet "Six," the Ford Model "A," and others. By loosening the generator, Fig. 28, and swinging it to the side, proper tension is placed on the fan belt, which serves as a fan and generator drive. It is not necessary to have the "V"-type belt running as tight as a flat belt. Use care when adjusting the fan belt not to have it too tight.

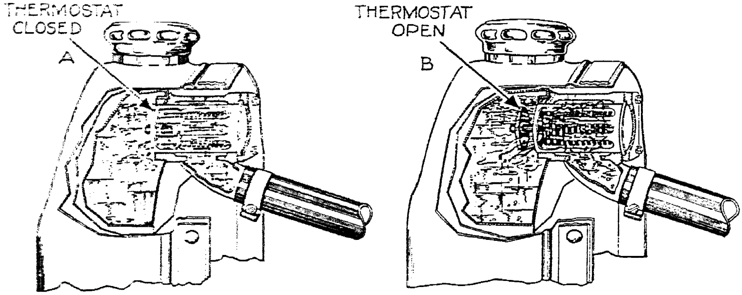


Fig. 27. How the Thermostat Controls Radiator Solution Circulation

A-C Thermo-Gauges. The A-C thermo-gauges are used in connection with the automobile engine so that the driver of the car may know the operating temperature of the engine. These thermo-gauges are in reality heat indicators. The principle of operation is quite similar to that of any pressure gauge. However, in this case there are three individual parts of the installation. One of these is the gauge itself which is mounted on the instrument panel. Another one is the bulb which is necessary as the unit in which the pressure is developed by the heat of the water in the cylinder jacket, and the third unit is the capillary or small metal tube which is used to connect the bulb to the Bourdon tube of the gauge.

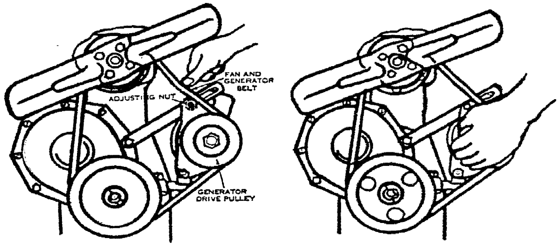


Fig. 28. Adjusting the Chevrolet "Six" Fan Belt by Moving Generator Outward

The gauges themselves are made in two types, either the gearless type or the gear type. In the gear type the regular and heavy-duty gauges are regularly produced. The gearless type is illustrated in Fig. 29.

The thermo-gauge bulb is illustrated in Fig. 30. In this figure, three sizes of bulbs are indicated—the small, the medium and the large. The distance from the gauge to the bulb installation, that is, the length of the capillary required, determines the size of bulb to use. Another feature entering into this is whether the gauge is of the gearless type or whether it is of the gear type. A smaller bulb is recommended for the gear type, because of the smaller amount of motion of the Bourdon tube required to move the pointer the same number of graduations on the face of the gauge.

It will be noted that in Fig. 29 the Bourdon tube has one hand anchored and the other one is free to move so that as it moves under the pressure from the bulb liquid as it is vaporized, it in turn pulls the connecting link, causing the pointer crank mechanism to move the pointer.

A highly volatile liquid is placed in the thermo-gauge bulb so that as the water of the engine is warmed by the operation of the engine, it is vaporized and a pressure is caused to flow through the capillary to the Bourdon tube. The greater the heat in the engine the greater the pressure within the tube, and the more movement of the pointer.

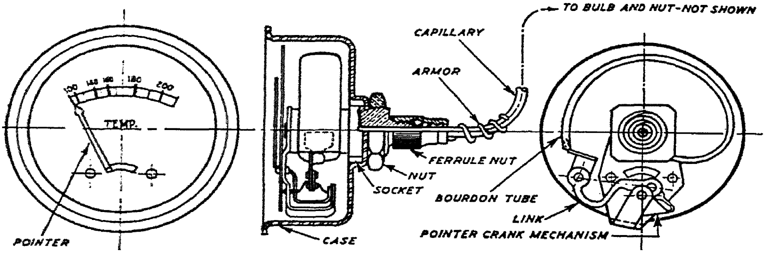


Fig. 29. AC Thermo Gauge
Courtesy of AC Spark Plug Company

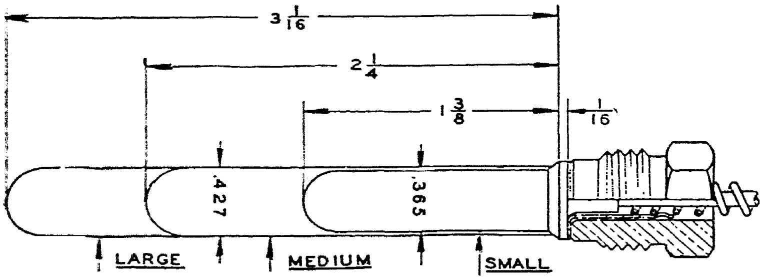


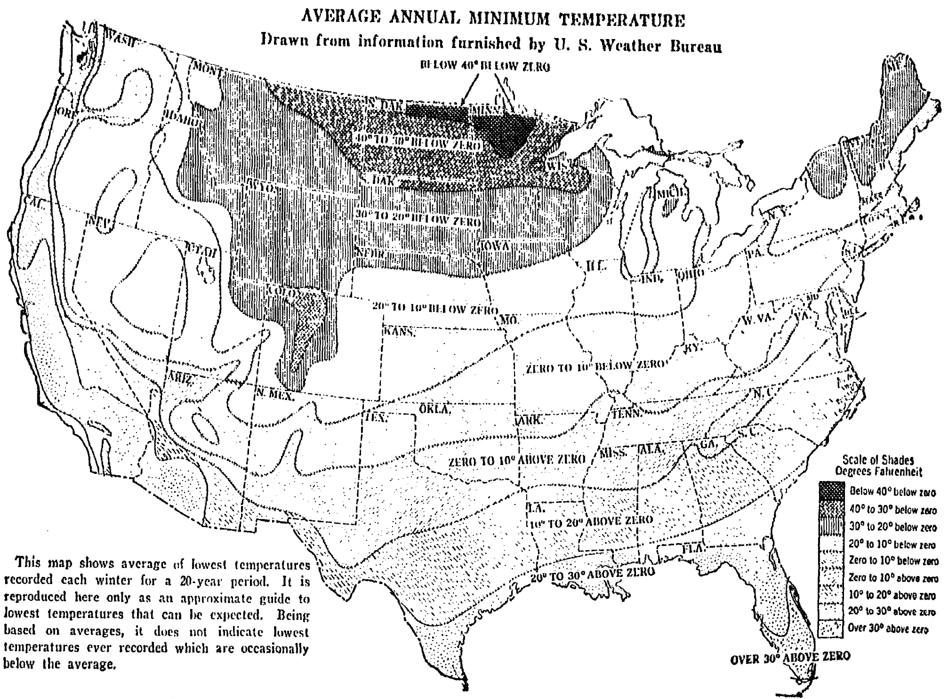
Fig. 30. AC Thermo Gauge Bulb

Most service men will never have need of engineering the A-C equipment into a job not previously supplied. When equipment fails, of course, replacements of identical equipment are always safe. The service man might be interested in knowing that the small gauge bulb installation is used with the gearless type gauges when the capillaries are not more than eight feet in length. A medium bulb is used with the gear type gauge when capillaries are not longer than eight feet and on all heavy-duty gauges with capillaries up to twenty feet. The large bulb is used with the heavy-duty gear type gauges when capillaries run from twenty to thirty-five feet in length.

One of the most common difficulties encountered in servicing these thermo-gauges has to do with the installation of car heaters and the removal of car heaters. For the bulb to operate properly, it is necessary that it be introduced into a position in the water jacket where the heated water is flowing around it. This, naturally, is done by the engine manufacturer. However, when the service man installs a heating unit, he sometimes has occasion to move this bulb with the result that not the same heating effect is secured with reference to the device. This may result in a temperature reading which is less than actually exists in the engine. As a consequence this may lead to a false sense of security on the part of the operator of the car, since he believes that his engine is actually operating at a temperature many degrees below that which exists.

Ordinarily no difficulty is encountered with this equipment unless the hot water heater is cut off by closing off a valve so as to prevent circulation of the water. In some cases difficulty is encountered when the service man disconnects the hot water heater and leaves the thermo-gauge bulb sticking out in a length of pipe where no water is circulating around it. In all cases the bulb should extend into the water which is circulating and approximately ⅛ inch of area should be available for this circulation at all points around the tube. Never permit the thermo bulb to be installed in a hot water pipe or tube in which the water is not circulating.

AVERAGE ANNUAL MINIMUM TEMPERATURE
Drawn from information furnished by U. S. Weather Bureau



This map shows average of lowest temperatures recorded each winter for a 20-year period. It is reproduced here only as an approximate guide to lowest temperatures that can be expected. Being based on averages, it does not indicate lowest temperatures ever recorded which are occasionally below the average.

A MAP WHICH PREDICTS ANTI-FREEZE SALES AND SERVICE DATES FOR YOU

Courtesy of National Carbon Company Incorporated

MANIFOLD CONSTRUCTION

An engine is equipped with a number of external fittings more or less in the form of pipes or hollow passages which are termed manifolds. These are the intake gas and exhaust gas manifolds, Fig. 1. Those portions of the intake and exhaust manifolds which are found within the cylinder block or cylinder head are called ports. The manifold itself is the unit which is bolted to the block or cylinder head.

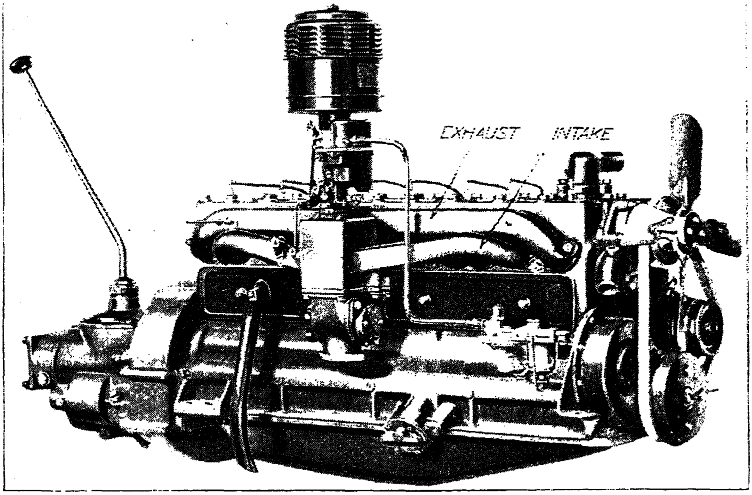


Fig. 1. Pontiac Engine Manifold System, Showing Intake and Exhaust

The purpose served by the manifold is well illustrated in Fig. 2, which is a cross section of an engine, showing the carburetor, intake manifold, valve, piston, and cylinder arrangements. A further study will show that the intake manifold is surrounded by other jackets. The intake manifold *AA* connects up to the port *B*, in which the intake valve is located. A damper *D* is shown in the upper portion of the exhaust manifold.

When this damper is closed, the exhaust is forced out into the lower sections *C* of the exhaust manifold.

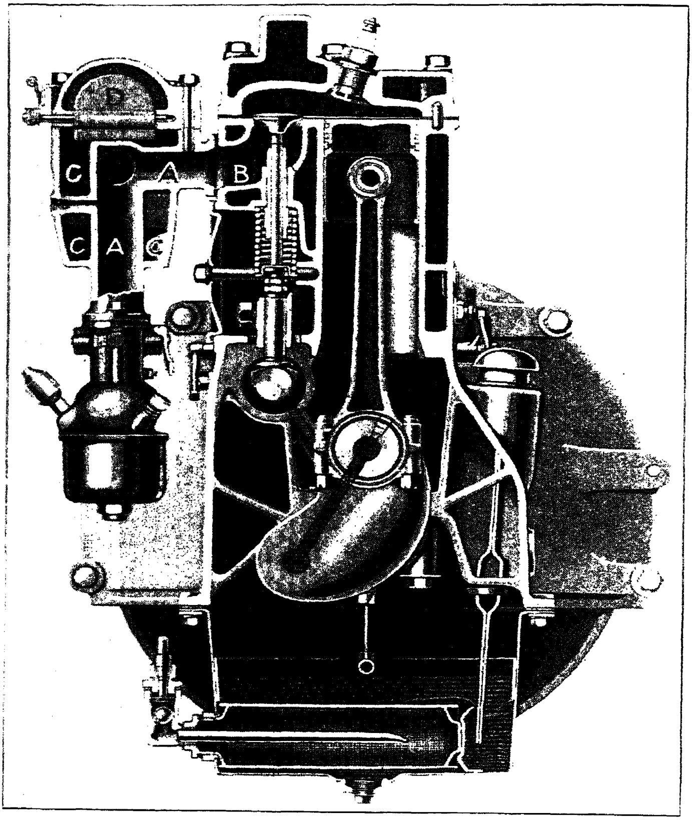


Fig. 2. Cross Section of Manifolds, Ports and One Cylinder of a Typical Vertical Automobile Engine

Most of the principles which are involved in manifold construction are shown in this figure. The combination of the two manifolds—intake and exhaust—is usually considered a desirable feature. It is very difficult to vaporize the heavy ends of the gasoline so widely distributed for motorists. This accounts for the combination of the two manifolds, together with the hot spots and similar features.

Intake Manifolds. The design of the manifold has a great deal to do with the efficient operation of the internal-combustion engine. For smooth and even running, the charges taken into the cylinder should be of the same strength and quality. In other words, the charge taken into one cylinder should not be richer or in a better state of vaporization than the charge taken into another cylinder.

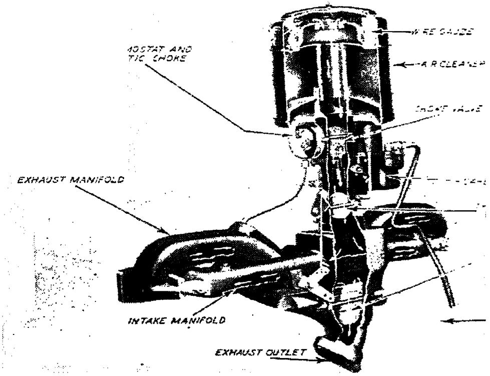


Fig. 3. Oldsmobile Fuel System Showing Intake and Exhaust Manifolds
The cutaway with arrows shows the path of fuel into engine through the intake manifold and out through the exhaust manifold.
Courtesy of Olds Motor Works

The distribution of the fuel to the cylinder should, therefore, be as even as possible, which depends greatly on the design of the intake manifold. The ideal form of charge is one that consists of dry gas, but the present-day fuel prevents such a charge unless the mixture is subjected to a high temperature. If the charge is too highly heated, the volumetric efficiency is destroyed and the power output of the engine drops off. A compromise between these two mixtures is used and the charge is introduced into the cylinder in the form of a gas fog. Even this has its disadvantages as some of the fuel will be deposited on the walls of the cylinder and manifold. The manifold should, therefore, be designed so that wall condensation is reduced as much as possible. If condensation does occur, each cylinder will then receive its equal share of the wet mixture which is taken up by the incoming charge.

Four-Cylinder Intake Manifolds. The firing order and the valve timing also have something to do with the design of the manifold. When two cylinders in the same block next to each other fire one after the other and the intake valve opens a little before the previous intake valve closes, there is a possibility of a supply of gas to the first cylinder being cut off by the suction of the second cylinder. See Figs. 3 and 4.

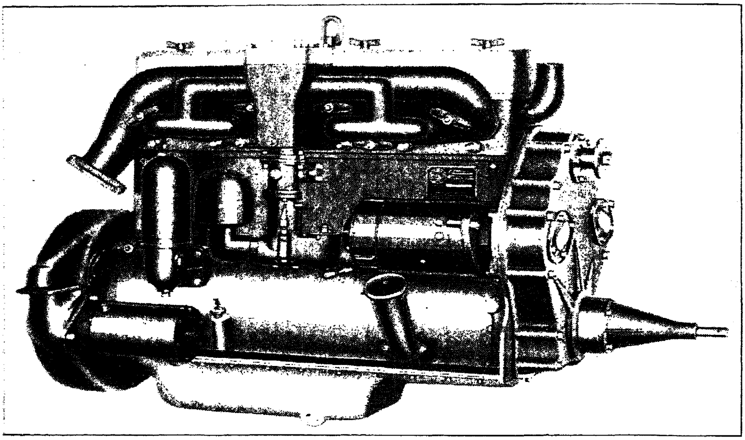


Fig. 4. Manifold and Carburetor System of the Continental Six-Cylinder Overhead Bus Engine

The inside of the intake manifold should be smooth and the passages should be large enough so that there is no obstruction to the flow of gases. The bends in the manifold should be so designed that the movement of the gases will prevent any fuel accumulating on the walls of the manifold through condensation. The flat-bottom manifold is well adapted for heat application and quick vaporization of condensed fuel moisture on its walls, as the drops of moisture fall to the floor at once. This applies to all manifolds whether for four, six, or more cylinders.

Six-Cylinder Intake Manifolds. The design of a manifold for a six-cylinder engine is governed by the firing order of the engine and, of course, that is governed by the placing of the cranks. In most six-cylinder engines the intake valves and ports are so laid out that two intake valves draw their charge for the same manifold connection. The most desirable arrangement for the six-cylinder engine is to have the suction in the intake manifold come from opposite ends of the engine. This prevents any one branch accumulating more moisture than another. There are two firing orders which allow this and they are the orders in use at the present time—1-5-3-6-2-4 and 1-4-2-6-3-5.

In most manifolds the bends have been made with radii, because it was thought that abrupt turns prevented the easy flow of the gas mixture. A later design of manifold that has proved successful is one of square cross-section. See Fig. 5. This manifold has the flat floor and all gas passages are exactly alike in shape. It is claimed that the abrupt turns tend to keep the particles of gasoline in the stream flow of the gases and direct them in a straight line. The turbulence set up by the abrupt turns helps to keep the particles in suspension at all times. Any particles of gasoline that may accumulate on the roof of the manifold and drop down must fall into the gas stream, while the square section gives the greatest floor area for the evaporation of the condensed fuel that might accumulate there.

Intake Manifolds for Eight-in-Line Engines. Two types of carburetors are used in connection with the eight-in-line engine. These are the single barrel and the double barrel or the single and the duplex carburetor. When the duplex carburetor is used, the manifolds are so arranged that four cylinders are fed from each side of the carburetor. This means a better distribution of gas. For instance, the cylinders 1-2-7-8 are fed from one side of the carburetor or barrel and cylinders 3-4-5-6 are fed from the other side of the carburetor or barrel with the result that more even distribution of gas is secured.

Fig. 5 illustrates the Studebaker intake manifold design which is used in connection with the Studebaker eight-cylinder engines which are fitted with the duplex carburetor. It will be noted that there are four horns running to the engine. Each one of these is designed to care for two cylinders. It will further be noted that the manifold is wider at the center, in fact it has two distinct passages at the center. A short section of the manifold feeds cylinders 3-4-5-6 and the longer section of the manifold feeds cylinders 1-2-7-8.

The down-draft principle of manifold design represents certain engineering advance. While serving to bring the carburetor higher and thus shorten the lift required for the gasoline, in the carburetor, it serves to help in securing an equalization of the distribution of any globules of gasoline which may condense within the manifold. It will be seen at once that the gasoline which condenses in this type of manifold is certain to find its way into the engine rather than flow back into the carburetor, that is, this happens if the condensation occurs after the sloping portion of the manifold has been reached. Any condensation which occurs before this point is reached will find its way back into the carburetor where it will either be returned to the carburetor bowl or revaporized, depending of course upon the design of the carburetor.

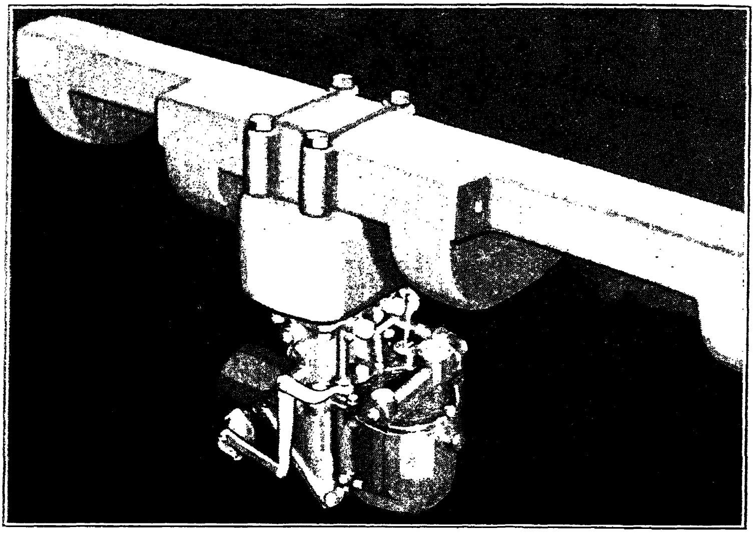


Fig. 5. Studebaker "Straight Eight" Intake Manifold with Duplex Carburetor

Hot-Spot Manifolds. It is very desirable to place the carburetor close to the cylinders so that there will not be a great deal of condensation in the lower part of the intake manifold. In a system where a long riser pipe was used, a great deal of the condensed gasoline would drain back into the carburetor and cause loading and a means had to be devised to vaporize this fuel. The hot-spot manifold was the outcome, Fig. 6. It is so constructed that a portion of it, consisting of solid metal, is in constant contact with the exhaust manifold so that in continuous running this solid metal in the intake manifold becomes heated, perhaps to a high degree. Furthermore, this "hot spot" is so located in the inlet passages that all fuel must pass over it before passing to the cylinders, with the result that any unvaporized particles remaining in the fuel gas are thrown against this highly heated spot and vaporized

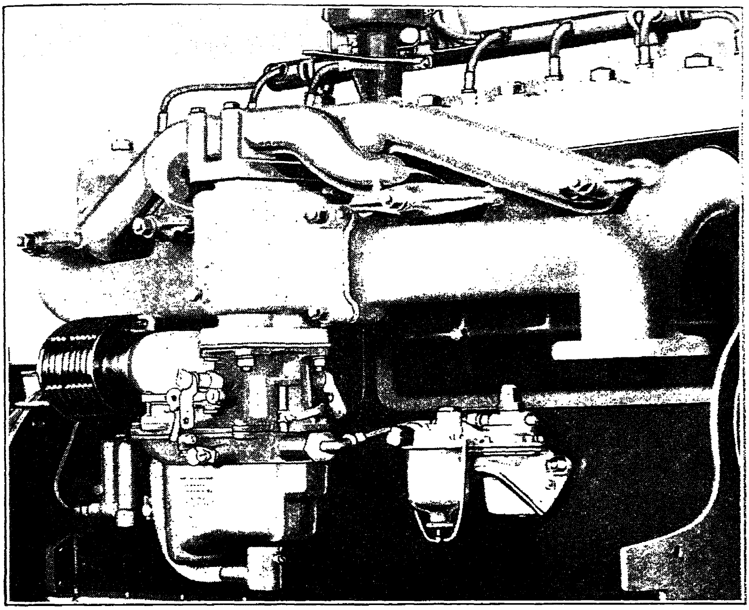


Fig. 6. Down-Draft Manifold for Duplex Carburetor and Eight-in-line Engine

instead of being carried into the cylinders as liquid particles, as would be the case without this heated spot.

An example of the application of the so-called "hot spot" is illustrated in the Oldsmobile manifold construction shown in Fig. 3. The intake manifold passes through the central section of the exhaust manifold with the result that much of the heat needed to vaporize the heavy ends of the raw gasoline is picked up by the fins cast on the outside of the intake manifold and given off to the incoming fuel charge. This results in better and more complete vaporization and in the drying out of the fuel charge.

Importance of Handling Exhaust Gases Properly. The design of the exhaust pipe should be such that it excludes any chance of back pressure. It must be remembered that in multiple-cylinder engines, the strokes overlap. Consequently, at certain parts of the cycle there are two cylinders exhausting at the same time and the exhaust pipe should be large enough to take care of both. The exhaust pipe should gradually increase in size toward its outlet so that there will be no restriction. When a curved exhaust pipe is used, care should be taken in the layout of the curves so that a cylinder that is exhausting at high pressure does not blow over into a cylinder in which the pressure is low and in which the exhaust valve is open.

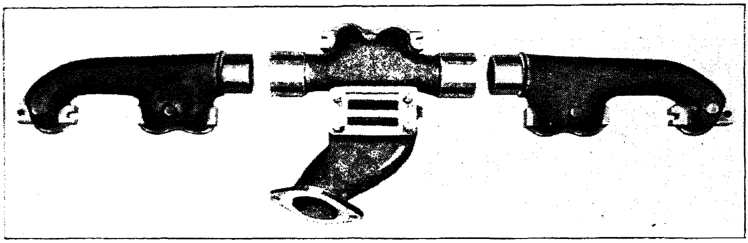


Fig. 7. Buick Three-Piece Exhaust Manifold

Muffler. The purpose of the muffler is to reduce the pressure of the gases by expansion to a point where they will emerge into the atmosphere without noise. This is generally done by providing a number of concentric chambers. The gas is allowed to expand from the first passage into the much larger second one, then into the still larger third one, and so on, to the final and largest passage, which is connected to the pipe leading out into the atmosphere. This is not as simple as it sounds, for, if it is not well and wisely done, there will be back pressure which will reduce the power and speed of the engine, cause heating troubles, and may possibly cause the motor to stop.

Buick Exhaust Manifold. Fig. 7 illustrates the three-piece exhaust manifold used by Buick automobiles. The center section is used to carry the exhaust manifold valve which controls the amount of heat furnished to the carburetor riser, this being supplied through the slots appearing on the face of the manifold. The two end sections are fitted to the center section by means of a slip joint. This arrangement is provided in order to care for the normal expansion and contraction of a long engine block under temperatures encountered in normal usage. The end sections slip within the joint on the center section. In case old parts are being replaced with new and it is necessary to fit several of these together, the joint should be lapped by means of fine grinding compound. It should not be filed. When reassembling the joints they should be lubricated with a thick paste made of flake graphite and just enough engine oil to make the graphite stick to the two halves of the joint. The joint between the heat valve cover and the center section is secured by means of graphite and in case the joint is ever broken for repairs of any kind graphite should be used when it is being reassembled.

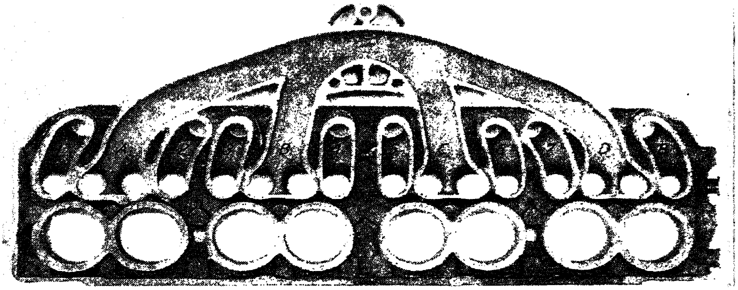


Fig. 8. Hudson Radial Intake Manifold

Hudson Radial Intake Manifold. Fig. 8 illustrates a sectioned view of the Hudson manifolding system. Both the intake and exhaust passages have been cut away to illustrate them. The intake passages are lettered *A*, *B*, *C*, and *D*, each one of these passages supplying fuel charges to the two valve ports connected therewith. The exhaust passages are numbered 1, 2, 3, 4, 5, 6, 7, and 8, each of these passages being connected to one of the exhaust valves. This cutaway view shows sections of the cylinders. As a matter of fact the cylinder block has the intake and exhaust passages cast partially within it, other parts of the manifolding system being bolted to the block.

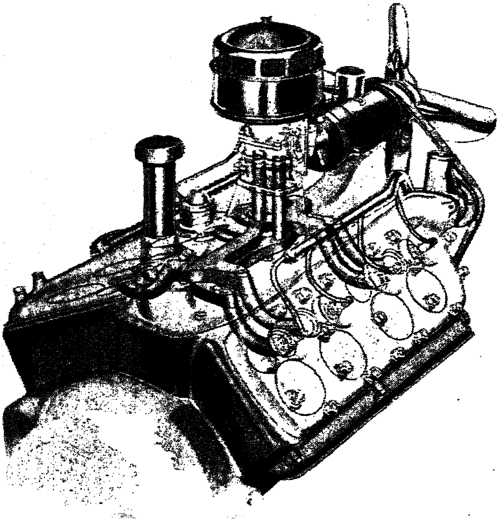


Fig. 9. Ford "V-8" Intake Manifold System

The advantage of this type of construction lies within the fact that incoming fuel charges are heated to an even temperature inasmuch as the intake passages are surrounded by the cooling solution contained within the engine block, as are also the exhaust passages, so that an even temperature is maintained throughout the system.

Ford "V=8" Intake Manifold. The intake manifolding system of the Ford "V-8" as well as the down-draft carburetor features are illustrated in Fig. 9. It will be noted here that the two barrels of the down-draft carburetor are connected with the riser tubes and that each one of these tubes in turn is connected with a system of manifolds cast within the aluminum manifold header. If the student will follow out the path of one of these tubes from the carburetor to the manifold and then from it to the four cylinders fed by that barrel of the carburetor, he will see that the distance to each cylinder is approximately the same, also that there is no connection between the two tubes. This aids in giving each cylinder an equal fuel mixture and assures much more even operation than

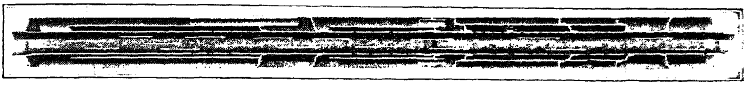


Fig. 10. Buick Resonance Muffler

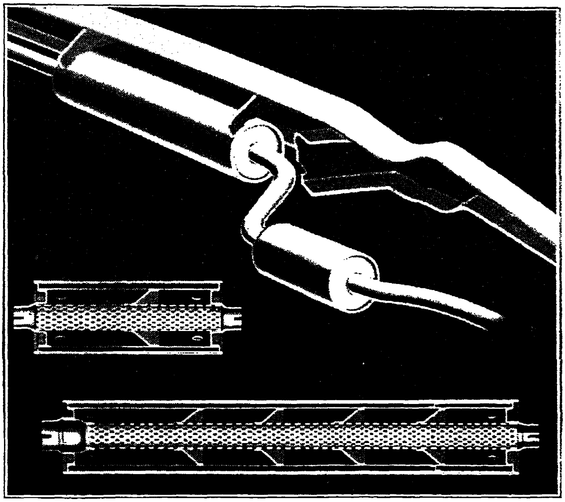


Fig. 11. Nash Exhaust Muffler System

where the eight cylinders are fed from one intake manifold. This arrangement also results in a considerable increase in power.

Exhaust from the engine is conducted through passages cast in the cylinder block to the exhaust manifolds which are bolted to the outer edges of the two cylinder blocks. These passages are not shown in the phantom view, Fig. 9.

Buick Resonance Muffler. The Buick muffler, Fig. 10, is a straight-through resonance type, consisting of a central tube open for the full length of the muffler, and having openings into resonance chambers. The resonance chambers function in the same manner as those used in the intake silencer and air cleaner. This type of construction results in greatly reduced back pressure and as the exhaust gases are not appreciably cooled in the muffler the corrosion from condensation and burning of the tubes is reduced to a minimum.

Dual Mufflers. Fig. 11 illustrates the Nash dual muffler connected to the car frame above and in sectioned view below. It will be noted that these mufflers are of the straight-through type, being provided with a central tube perforated with many openings into the outside chamber. The expansion of exhaust gases through these openings into the outer chamber results in their coming in contact with the outer wall which is constructed of several thicknesses of sheet metal with asbestos between. Practically all exhaust noises are eliminated by using two of these mufflers and allowing the gases from the larger one to flow through a tail pipe into the smaller one, and from it through a tail pipe into the open atmosphere.

Muffler Troubles. When the engine mysteriously loses power, it is well to look at the muffler. A dirty muffler filled up with oil and carbon, which results from the use of too much oil in the motor, will choke up the passages so that considerable back pressure is created. When this is suspected, tap the muffler all over lightly with a wooden mallet, and the exhaust gases will blow the sooty accumulations out.

On six-cylinder motors, and particularly motors with more than six cylinders, the sound of the exhaust is not an accurate guide to the firing of the cylinders, except for the expert mechanic with unusually keen hearing.

Muffler Abuse. The abuse of the muffler is dangerous to the muffler, to the car, and to the public. Fig. 12 illustrates a muffler which was "shot" once too often. In this case no damage other than that to the muffler occurred. The practice of running an engine and then turning off the ignition to allow the muffler to "load" and then turn on the ignition and "shoot" is to be discouraged by all first-class mechanics. It may result in the loss of life. Instances are on record where mufflers have been blown for many yards with disastrous results.

Buick=Delco=Remy 1937 Manifold Heat Control. The intake manifold of the Buick is of the twin type integrally cast. The outside branch is used to supply cylinders numbers 1, 2, 7, and 8, and the inside branch supplies cylinders numbers 3, 4, 5, and 6. A heat jacket is cast around the center section and is connected with the exhaust system.

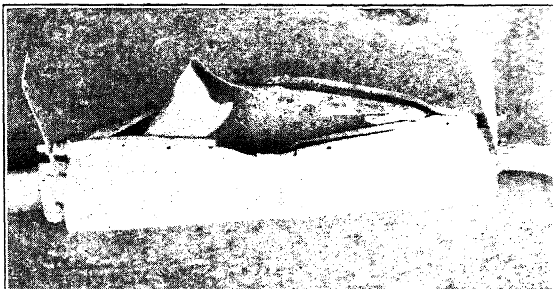


Fig. 12. A Muffler Which Was "Shot"

The intake manifold of the Series 60-80-90 cars is provided with a drain directly below the barrels of the carburetor. This drain prevents any excessive raw fuel from the carburetor flowing into the branches of the intake manifold, and passing onto the cylinders to cause trouble. During the cranking operation, fuel at the bottom of the manifold is atomized by means of the stream of air from the outside of the manifold being drawn through the drain. The passage through which the air passes during the cranking is provided with a check valve which is closed by vacuum as soon as the engine starts operating. This will remain closed as long as the engine operates under its own power. When the engine stops, as in cranking, this drain, shown in Fig. 13, operates to prevent flooding of the engine with raw fuel.

Intake Manifold Vacuum Gauge. If it is desired to check the vacuum within the intake manifold, a vacuum gauge should be used. Reading should be taken with the engine idled at a speed of approximately 8 miles per hour. It will be found that engines in good condition will draw a vacuum of from 18 to 20 inches mercury in low altitude sections of the country. On a properly tuned engine, the vacuum indicator needle should be steady. If the needle fluctuates and will not hold a steady reading, it indicates improper functioning of the engine. For complete information on using the vacuum gauge in testing to determine engine fault, the reader is referred to the Motor Analyzing Section in Volume Six.

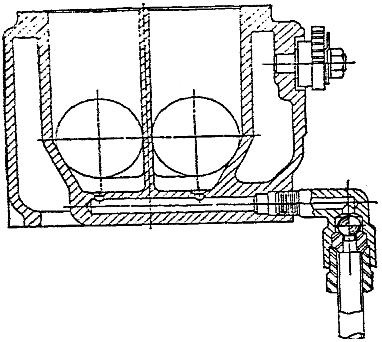


Fig. 13. Buick Intake Manifold Drain
Series 60-80-90

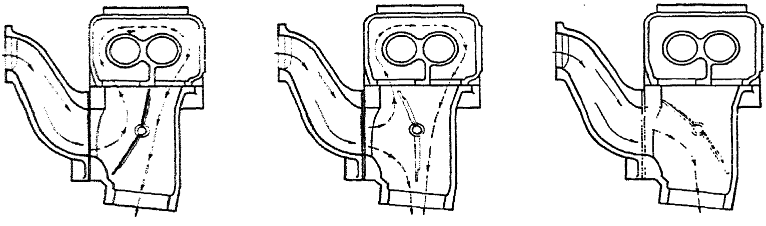


Fig. 14. Buick Heat Control Valve Operation

Operation of the Buick Heat Control. The Buick intake manifold feed control system utilizes the exhaust gases of the engine to insure complete vaporization with a minimum consumption of fuel. This result is accomplished by surrounding the center portion of the intake manifold with a heat jacket, Fig. 14. which is connected to the exhaust system. As the hot gases pass from the exhaust manifold into the heat controlled valve body, they strike the heat controlled valve and are lifted upward into the heat jacket around the intake manifold. The gases next pass out of the heat jacket back into the heat valve body, but on the opposite side of the heat controlled valve. Thus, the heat controlled valve acts both as a valve and as a partition. The amount of heat delivered to the heat jacket is automatically controlled by means of a thermostat which governs the quantity of exhaust gases and, consequently, the amount of heat by determining the position of the heat controlled valve. As shown in Fig. 14, the greatest amount of heat is available when the valve is in the "heat-on" position. The amount of heat decreases to the "heat-medium" position and the "heat-off" position. The heat control valve is so designed that when the engine is operated under

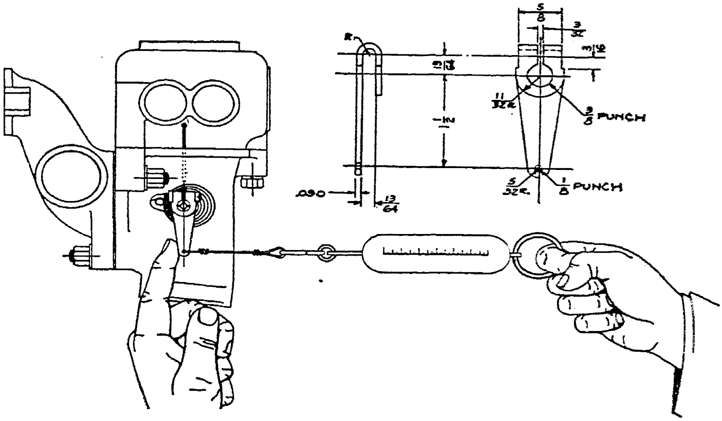


Fig. 15. Checking 1937 Buick Heat Control Thermostat
Courtesy of Buick Motor Company

wide open throttle conditions the force of exhaust gas causes valve to be held open, since one side of the valve is longer than the other.

The thermostat is shown in Fig. 15. It controls the heat of the control valve automatically. Setting of the thermostat should be approximately ¼ turn wind-up at normal room temperature, causing tension to be applied to the damper valve, holding it in the heat-on position and forcing the exhaust gases through the heat jacket. Heat conducted by the damper valve shaft of the thermostat causes it to unwind, reducing tension on the damper valve which allows the valve to be forced by the exhaust pressure toward the off position. The thermostat is also affected by the temperature of the air blast from the fan. Thus, we find that the heat control varies with outside air temperature, as well as directly from exhaust heat. The thermostat proper is made of two strips of metal of unequal expansion characteristics. These two metals being fastened together as one strip. When heat is applied to this bi-metal, it has the effect of causing the thermostat coil to wind or unwind. This serves to actuate the valve shaft and controls the amount of heat.

Thermostat Tension. If it is found desirable to check the tension on the thermostat, this operation should be carried out as indicated below. The first step is to have the whole manifold assembly at room temperature (approximately 70 degrees). Next, attach a spring balance to the lever and note the pull the instant the lever begins to move. This movement may be determined by holding the finger lightly against the back of the lever as shown in Fig. 15. In the case of the 40 Series Buick, the pull should be 3½ to 4½ ounces and in the cases of the 60-80-90 Series Buicks, the pull should be 8 to 9½ ounces. Before making this test, make certain that all moving heat controlled parts operate freely, but in no case should oil be used on these parts.

Heat Valve Position Adjustment. When the engine is cold, the heat valve is held in the closed position by the tension of the thermostat spring. This closed position is indicated by the approximate vertical position of the counterweight lever. A spring acts as an anti-rattle device and resists the tendency of the thermostat spring to throw the weight lever completely up to the vertical position where the valve would contact the housing. If adjustment is necessary, it is made by bending the regulating clamp.

CLUTCHES

The history of the automobile clutch is intimately connected with the history of all mechanical developments. In quite a few cases, designers attempted to apply machine-shop practice with reference to automobile clutches. Owing to the fact that the gasoline engine will not start when carrying a load nor develop appreciable power until it has reached a certain minimum operating speed, about 300 to 400 r.p.m. with automobile engines, some form of clutch is absolutely essential.

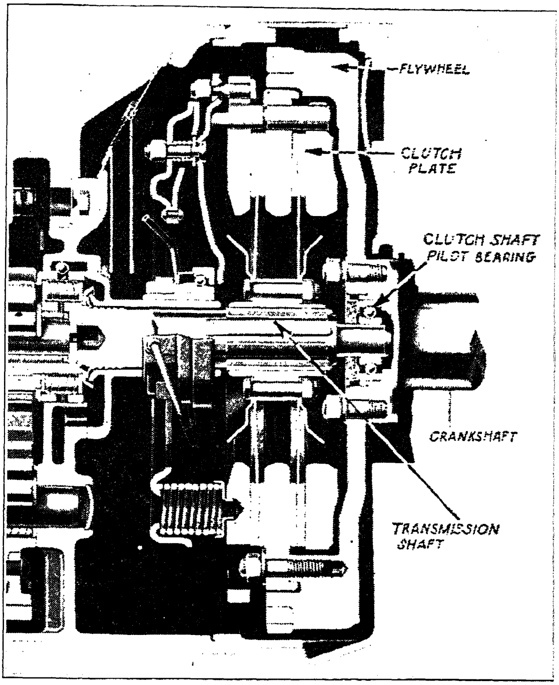


Fig. 1. Double Plate Clutch
A—Flywheel. *B*—Clutch Plate. *C*—Clutch-Shaft Pilot
D—Crank Shaft. *E*—Transmission Shaft.

The clutch, Fig. 1, is used to disengage the engine from the transmission and rear axle when the engine is idle, when the car is standing, or when shifting from one speed or gear to another, Fig. 2. A prime essential in clutch action is an easy

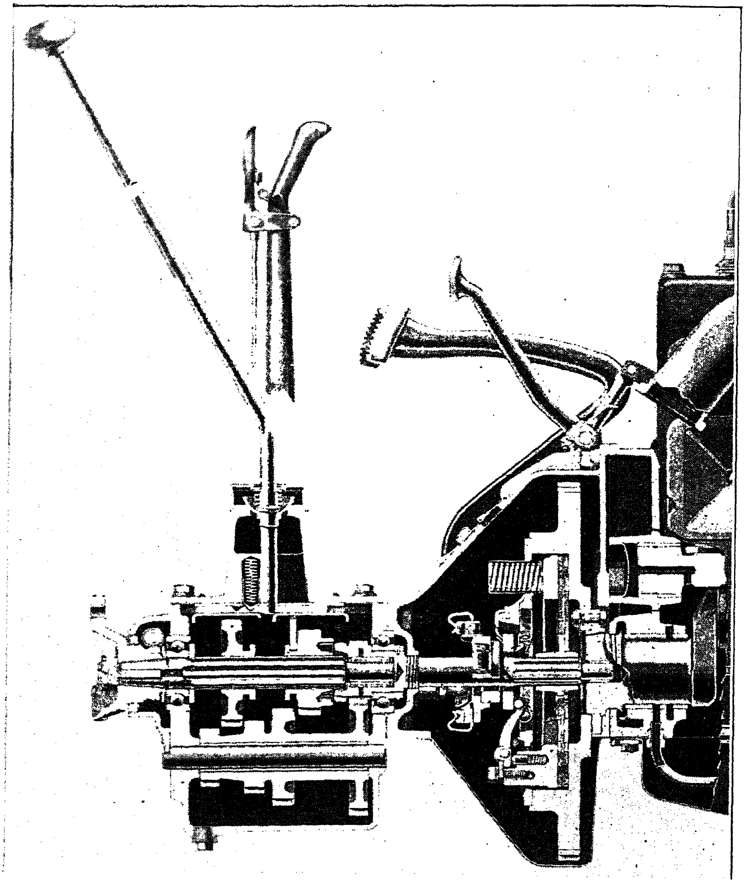


Fig. 2. Conventional Single-Plate Clutch and Selective Gear Set in Sectioned View

quiet take-up of the load. When a car is standing and the engine is running at an average speed of about 400 r.p.m., it will be impossible to have the car speed instantly synchronized with the engine, as this would mean that the car speed would have to come from zero to approximately 10 miles per hour instantaneously. The clutch is required to bring the car speed into line with the engine speed in a gradual manner, which means that the clutch is always slipped as it is engaged to take up the load. This is normal slipping and must not be confused by the mechanic with abnormal slipping, which means that the clutch continues to slip after the foot of the driver has been removed from the pedal.

It was exactly this situation which made the development of a simple and efficient clutch a difficult matter. Some very early forms of self-propelled vehicles made use of belts of the round or flat type, which were controlled by idlers and allowed to slip to give the gradual application of power which is required. These very early experiments were followed by the friction disc and wheel, another idea borrowed from the stationary machinery design of the times. In this case a friction disc was turned by the engine and a leather-lined wheel was brought into contact with the disc to give the gradual application of power. This gave a clutch action and at the same time a variable speed action, since the wheel could be moved across the face of the disc. The Carter car was the outstanding example of the application of this principle. The chief difficulty was burning up the leather lining on the driven wheel.

Cone Clutches. The earliest satisfactory form of clutch was that of the leather-lined cone, similar to that shown in Fig. 3, which illustrates the last popular application of this type of device as used on the Chevrolet "Four" automobile. The cone clutch is obsolete and is only interesting to the automobile mechanic as being one of the units which made the automobile a possibility.

The chief difficulty with the cone clutch was the tendency for it to grab or slip. Grabbing was due to the fact that a large amount of surface came into contact with the flywheel at practically the same time. This meant that a gradual application of the power was very difficult to secure. In order to overcome this tendency, coil springs similar to those shown at *A* in Fig. 3, were used. Mechanics servicing the cone clutches resorted to many subterfuges in order to secure the gradual easy application of power. They would hold the clutch in the out position and slip short lengths of flat spring steel or even match sticks or other bits of wood under the leather to give an uneven surface which would take hold gradually.

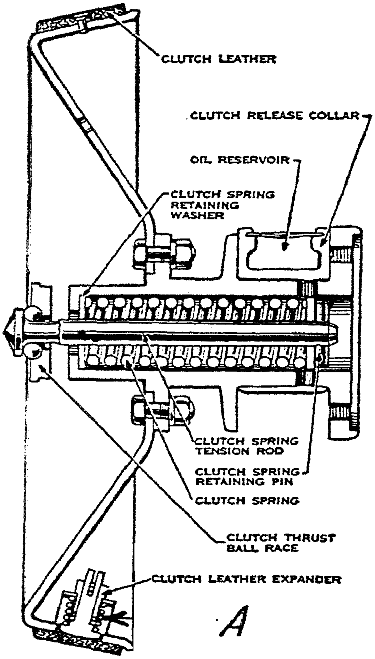


Fig. 3. Cone Type Clutch (Obsolete)

The later designs of the cone clutch were far more satisfactory than the earlier ones, but owing to the development of the plate clutch with its superior designs and performances. the cone clutch passed from the picture.

Multiple-Disc Clutches. One earlier development of the multiple-disc clutch made use of a combination of a disc and cone principle. Following this, the industry gave a very wide acceptance to the multiple-disc clutch. These were made in a wide range of design, using a variety of friction material for clutch facings. Fig. 4 illustrates a type of clutch long popular with cars in the higher price class and still very popular with trucks, busses, and tractor designers. The advantage of this type of clutch is a very large area of friction material which

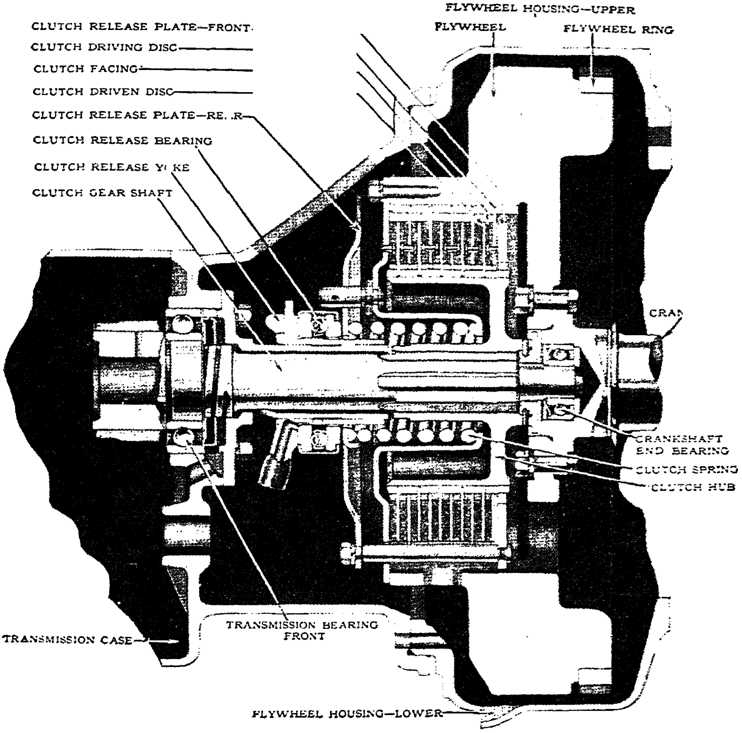


Fig. 4. Sectioned View of Multiple-Disc Clutch and Flywheel (Obsolete)

will give long life under heavy duty. An outstanding example of the success and popularity of the multiple-disc clutch was that of the Buick, Fig. 4.

Plate Clutch. The design of the plate clutch is quite similar to that of the multiple-disc, the main feature of difference being in the diameter of the plate as compared to that of the disc. As a rule the plate clutch is termed the single plate, although there are some examples of the plate clutch where two plates are used. When reference is made to the single plate, it refers specifically to that portion of the clutch which is used to receive the power.

The single-plate clutch has come to be considered the standard of designs in the automobile passenger-car field with the double plate clutch of similar design used largely for the heavier cars. A number of forms are used in the designs of this type of clutch. Consideration is given the matter of servicing, looking to an easy disassembling and reassembling of the job.

Clutch Facings. In order to secure satisfactory performance, a clutch facing must have certain definite friction qualities. Here again, the history of the industry is interesting. Originally leather was used almost exclusively, doubtless carrying over from machine-shop practice. When the brake lining became a definite automotive development, the same type of woven wire and asbestos material was used for clutch facings. For many years this continued quite popular, especially for use on plate or disc units. Further developments have given the industry hydraulic compressed clutch facings, which have no copper wire in them, and these are widely used.

The cork insert, such as is illustrated in Fig. 5, was originally designed for use in connection with both the cone and multiple-disc clutches. The outstanding example of the refinement of this design is the cork insert single-plate clutch used in the Hudson automobile. Another early development in the history of the automobile clutch was the use of steel and bronze or steel and steel clutch discs. Everyone is familiar with the application of this metal-to-metal principle in the case of the Ford Model "T."

Wet Clutches. When metal-to-metal surfaces were used, as in the case of the Ford Model "T" and certain of the earlier cars, it was necessary to run them in a bath of oil to prevent them being burned and unduly worn. It is a matter of record that practically all types of clutch facing materials have been used on jobs where the clutch was of the wet type. The wet clutch is the one clutch which makes use of the oil in the clutch housing. The Hudson multiple-disc cork insert and single-plate cork insert are examples of the wet clutch. About one-half pint of lubricant is used in the (flywheel) clutch housing, ordinarily composed of one-half engine oil and one-half kerosene.

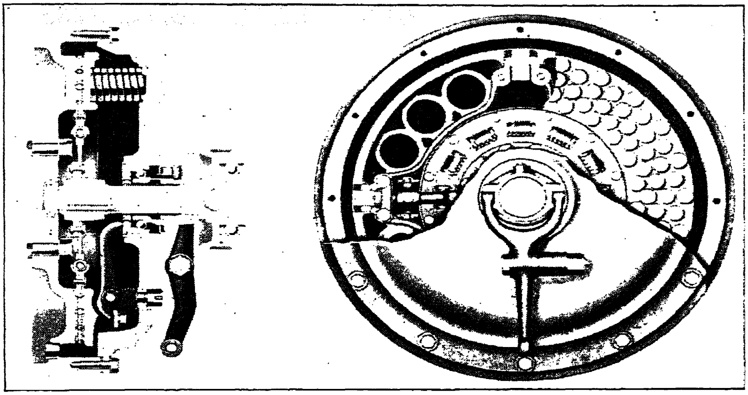


Fig. 5. Sectioned Side and Face Views of the Hudson Single-Plate Cork Insert Clutch Coil springs are used to absorb starting shocks

Dry Clutches. Practically all clutches are designed to operate dry. As a matter of fact, if oil or grease gets into the dry clutch compartment and on the plates, grabbing or slipping might occur. If too much oil enters, slipping is the usual result. If a slight amount of oil enters and becomes gummed with the dust worn from the clutch facings, the clutch facings may become glazed and grabbing is the result. The clutch facings in the dry clutch should operate without any oil, water, or foreign materials coming into contact with them. Under such circumstances, they will wear away in an even manner and the friction properties of the clutch will remain approximately constant.

Clutch Pressure Springs and Plates. In almost all single-plate clutches of modern design, the clutch springs are built within the clutch pressure plate. The clutch pressure plate is a device designed to bolt on to the rim of the flywheel and carries within it the springs and throw-out fingers or levers which exert the pressure and contract or compress the springs. Fig. 6 illustrates a Chevrolet clutch which has been disassembled.

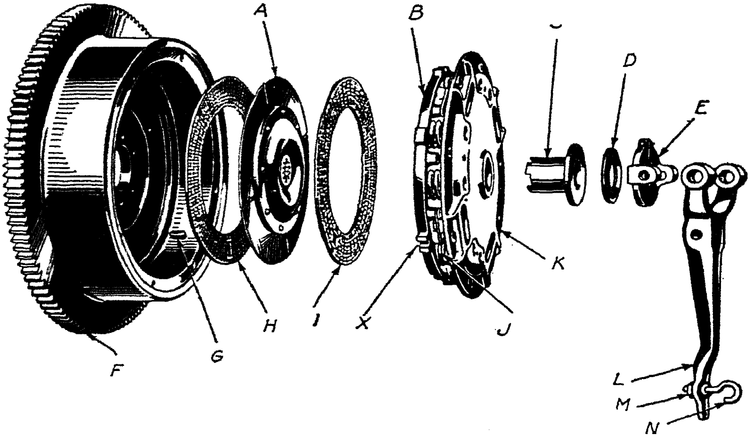


Fig. 6. Parts of a Single-Plate Clutch of General Motors Design

It will be noted that the flywheel *F* has within it lugs, one of which is marked *G*. These lugs are designed to fit into the inner face of the pressure plate at the points *X*, *B* thus affording a means of turning it with the flywheel. The outer portion of the pressure plate bolts on the flywheel along the rim, as indicated at point *K*. The compression fingers or levers within this pressure plate are not shown in this illustration.

The single plate is illustrated at *A* in Fig. 6. The two friction discs are illustrated at *H* and *I*. Ordinarily these are not fastened to the clutch plate *A*, although in some designs they are riveted to it. The other parts of the disassembled Chevrolet clutch are the clutch release lever *L*, which carries a yoke on its upper end, and a clutch adjusting screw *M* and eye *N* on its lower end. This yoke is connected with the collar *E*, so that when the clutch lever is pulled down, the collar *E* receives the pressure and transmits it to the sleeve *C* through the clutch collar bearing *D*. The notches in the end of the sleeve *C* engage with the inner ends of the levers in the pressure plate.

Clutch Throw-Out Collars. A clutch throw-out collar is illustrated in Fig. 7. These collars are designed to receive the pressure from the clutch yoke and transmit it to the inner clutch throw-out fingers or the clutch springs direct, depending upon the design of the clutch. More trouble develops with the clutch throw-out collars than with any other moving part of the clutch. Some of these collars are self-lubricating and others are provided with anti-friction bearings. It is not unusual for a clutch throw-out collar to give off a squeaking noise or a rattle because of wear which has occurred within the collar. Some designs are prone to become disassembled, with the result that the clutch cannot be thrown out. The repair man should give particular attention to this unit, lubricating it with oil or grease as the particular design of the clutch throw-out collar may require in the types requiring lubrication and further by keeping all lubricants away from the self-lubricating types.

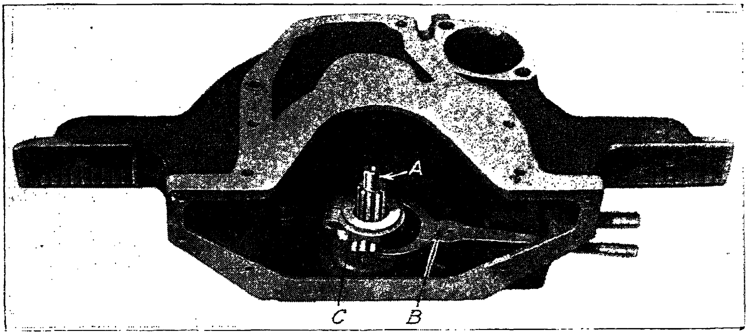


Fig. 7. An Oldsmobile Clutch Housing and Engine Mounting Bracketed with Clutch Shaft *A*, Throw-Out Lever *B*, and Throw-Out Collar *C*

Principles of Clutch Action. The clutch action is as follows: The engine flywheel is designed to carry the pressure plate on pins or some other means, such as lugs, from which the turning motion of the flywheel may be imparted to the driving units of the clutch. These parts become part of the weight of the flywheel. The driven unit, such as the plate *A*, shown in Fig. 6, receives the pressure from the friction discs and transmits it through the hub of the plate or other means to the clutch hub, from which point it is transmitted through the clutch shaft to the transmission. In all clutch designs, the driven member or members turn with the clutch shaft. In the case of the multiple clutch, Fig. 4, it will be noted that the inner discs are smaller in diameter than the outer discs. The inner discs attach to the inner drums by means of teeth or slots, while the outer discs attach to the flywheel by means of teeth, the outer edges of which mesh with the teeth in the flywheel rim.

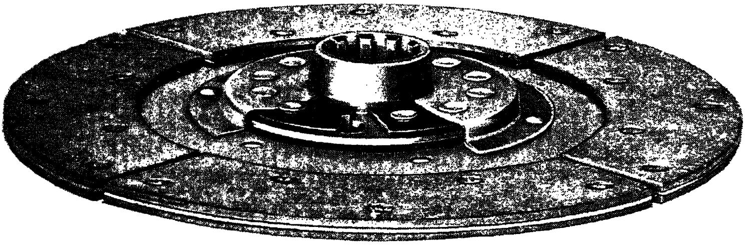


Fig. 8. Clutch Plate with Hub Mounted in Rubber

Influence of Weight. The weight of clutch parts is of slight importance insofar as the driving elements are concerned. The combination of the driving elements and the flywheel may be such as to give any desired weight to the assembly. On the other hand, the weight of the driven units has a very definite influence on gear shifting. If the weight is too great, the clutch will continue to spin after the clutch pedal has been depressed, with the result that it is difficult to synchronize the car and engine speeds, and clashing of the gears will result. This fact has had a greater influence on automobile clutch design than any one other item, and it accounts for the fact that the single-plate clutch has become so popular, since the light driven element slows down very rapidly when the clutch pedal is depressed and the clutch released.

Clutch parts must be manufactured with great accuracy, so that they may be mounted on the flywheel in balance with that unit. If any part of the clutch is out of balance, the power of the car, particularly at the higher engine speeds, will be considerably reduced. While engineers fully understand the detrimental influence of the lack of balance of any of the rotating engine or clutch parts, mechanics do not always understand it so well and may have difficulty to realize the cause of dissatisfaction with car performance as expressed by some customer. For this reason it is well to give thought to balancing and when making repairs to see that they are made in a workmanlike manner.

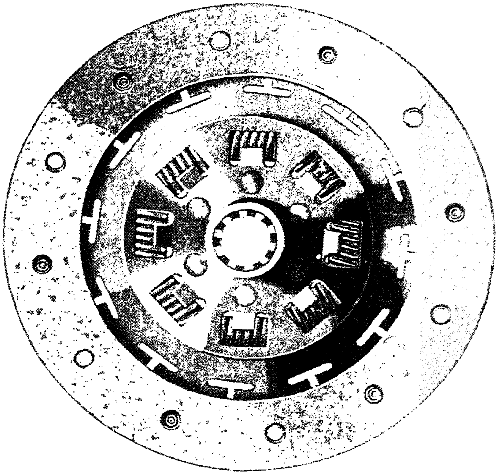


Fig. 9. The Single Plate of the Oldsmobile Is Mounted with Coil Springs so Arranged as to Give a Flexible Power Take-Up

Flexible Clutch Power Take-Up. Every car owner has been taught to expect smooth velvety pickup when the gears are engaged and the clutch let in. A number of designs have been evolved, looking toward a limited amount of flexibility between the engine and the positive drive of the transmission and the rear-axle units. At one time the flexible universal was used to a considerable extent. This did away with some of the harshness of power transmission. More recently a certain amount of flexibility has been designed into the power transmission line. This is accomplished by making the clutch-plate assembly flexible between the clutch-plate rim and the clutch hub. Fig. 8 illustrates a clutch plate with live rubber insulation placed in between the clutch hub and the plate, which smoothes out the driving effort and quiets the transmission operation. A similarly designed device is that illustrated in Fig. 9, which

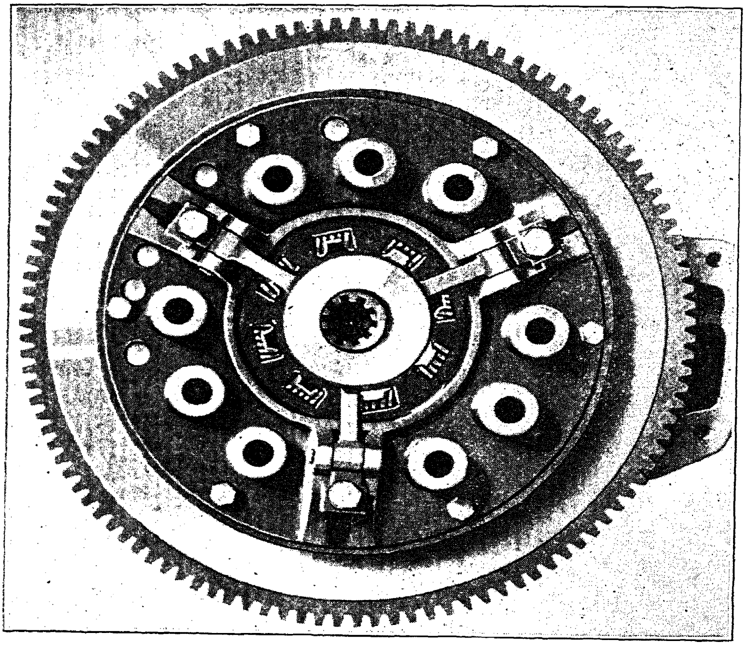


Fig. 10. The Coil Spring Single-Plate Clutch Hub Mounting in Position in the Clutch

shows the application of eight coil springs to the job of taking up the shock which occurs when the clutch is left in. These springs form the only connection designed to cause the rotation of the hub and inner section of the plate assembly when the power is transmitted through the flywheel and pressure plate of the outer rim of the driven plate shown in Fig. 10. This particular design is used on one of the General Motors products.

Clutch Noises. The most usual cause of noise in a clutch is the wearing of some of the driven parts and the splines in the clutch plate hub wearing, allowing play. Similar wear may occur at the points where the driven plates are mounted. Rivets or some other means of assembling the clutch hub to the clutch plate may become worn or loosened. When overhauling a clutch, all the parts should be carefully inspected to see if there is any undue wear. If such is found, the parts must be replaced. Generally this inspection is made when the clutch is down to have the friction rings on clutch lining replaced.

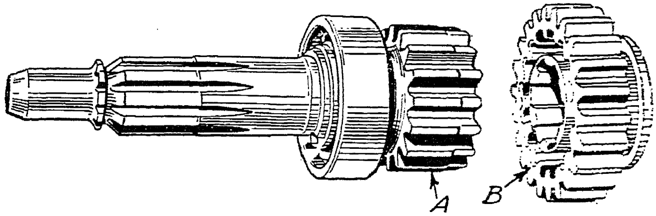


Fig. 11. A Sliding-Gear or Dog Clutch

Dog or Gear Clutches. It is not amiss to consider the dog or gear clutches at this point, since the action of these in connection with the clutch and transmission performance is a vital consideration. The dog or gear clutches have no part whatever with the car clutches just described. However, they do perform a similar piece of work, that is, when they are out, the driving member turns while the driven member remains stationary. When they are in, they turn as a unit. There is this difference, they may not be engaged gradually, since they are metal to metal contact, and the teeth *B*, Fig. 11, or dogs of the one engage with the teeth *A* or dogs of the other. They are used in connection with gear shifting in the transmission, notably when connecting the clutch shaft with the transmission shaft for high-gear position. These clutches take a variety of form and they must not be confused with the car clutch.

PONTIAC CLUTCH

The Pontiac clutch is of the single-plate type.* In the section view, Fig. 12, it will be noted that an eye-like hook, marked "clutch-pedal adjusting bolt," receives the pressure from the clutch pedal and operates on the clutch fork. This clutch-fork lever is mounted on the clutch-fork bracket, so that when the clutch pedal is depressed, the lower end of the clutch fork moves toward the rear of the car and the upper end of the fork moves forward, throwing a thrust, first, on to the clutch throw-out collar which transmits the force of the clutch throw-out bearing, and then on to the clutch throw-out bearing sleeve, the inner end of which sleeve is in contact with the clutch pressure lever. When the pressure comes to the clutch pressure lever, it is transmitted through it to the clutch lever plate. The clutch pressure plate is illustrated in Fig. 13. It will be noted

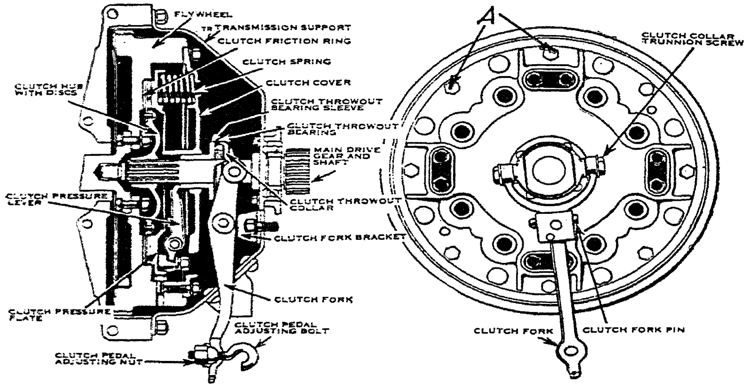


Fig. 12. Sectioned and Face View of Pontiac "Big Six" Clutch of General Motors Design. The Chevrolet "Six" clutch is quite similar, there being only a few minor differences.

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*The Pontiac and Chevrolet clutches are identical in most features.

that the clutch pressure levers are within this clutch pressure plate assembly, as may be seen in the sectioned view in Fig. 12.

By the use of these two levers, the clutch-pedal pressure is made light, while at the same time the number of springs within the clutch pressure plate is sufficient to give a good holding effect. When the clutch pedal is depressed, the clutch plates are released by the action of the two levers throwing a pressure on the clutch-pedal plate and forcing it rearward so that the two clutch friction rings are free to fall away from the clutch plate, thus releasing the clutch.

Servicing. The most important point with reference to the Pontiac clutch is maintaining the clutch-pedal adjustment, which should have between 1 inch and 1½ inches free travel from the floor board (measured underneath) before the pressure of disengaging is felt. Make certain when adjusting the clutch that the throw-out arm works freely on the pivot pin. Squeaking of this clutch is usually due to failure of maintaining the 1½ inches of clearance or there is a tendency of the car owner to keep his foot on the clutch pedal or to "ride" the clutch. The latter is the most usual cause, and the car owner must learn to keep his foot off the pedal. Where squeaking has been set up, the first thing to do is to secure the proper 1½ inches of clearance, after which a further remedy is injecting of kerosene oil through the clutch bell housing on to the clutch throw-out bearing. **Under no circumstances use lubricating oil on this bearing.**

NOTE. A later style bearing makes use of a bevel graphite bearing. Persistent causes of squeaking are remedied by replacing with the bevel graphite bearing.

Replacing Friction Disc. Fig. 13 illustrates the order of disassembling or assembling the clutch parts. When a transmission is pulled, the main drive gear and clutch shaft are pulled with it. The clutch pressure plate is fastened to the flywheel by means of set screws. When these are removed, the clutch pressure plate assembly may be lifted off. The clutch friction rings are not fastened to the clutch plate. A guide pin is used to align the clutch pressure plate and transmit the power from the flywheel through the plate of the friction disc

When reassembling the clutch, use an arbor which may be an old transmission or clutch shaft, and this will allow the clutch hub to be properly aligned with the clutch pilot bearing and the pressure plate. Once assembled the arbor may be removed, as the pressure of the assembled clutch will hold the parts in order.

CHEVROLET "SIX" CLUTCH

The Chevrolet "Six" clutch, which is very similar to those used on a number of the Chevrolet "Four" and the Pontiac cars and may be serviced in like manner, is a single-disc dry-plate clutch. The driving disc is made up of steel segments mounted on a clutch hub which is engaged by two friction rings placed on either side of the driving disc. See Figs. 12 and 13.

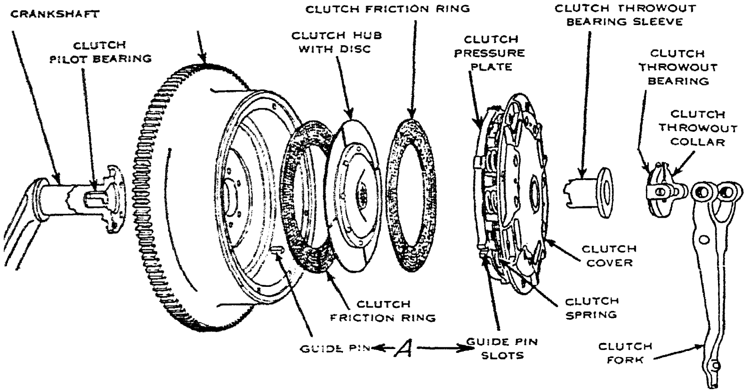


Fig. 13. The Pontiac and Chevrolet Clutch Parts

The clutch pressure is maintained by eight coil springs evenly spaced around the area of the pressure plate. The eight coil springs exert a pressure of 1,016 pounds with the clutch in, thus insuring a positive engagement between the motor and the transmission. The clutch is very simple in construction and operation. The few moving parts being assembled in the easiest manner insures accessibility from a service standpoint. The clutch is operated dry and should not be lubricated. The clutch throw-out bearing is graphite compound and needs no lubrication.

Disassembling the Clutch. If the clutch only is to be removed, it will be necessary to drop the rear axle torque tube. With the motor out of the frame and the transmission support removed, all that is necessary to remove the clutch is to loosen the eight cap screws *A*, Fig. 12, which hold the clutch cover to the flywheel, backing off each one one-half turn at a time until the tension is relieved and then the cap screws can be removed entirely. The parts of the clutch may then be removed.

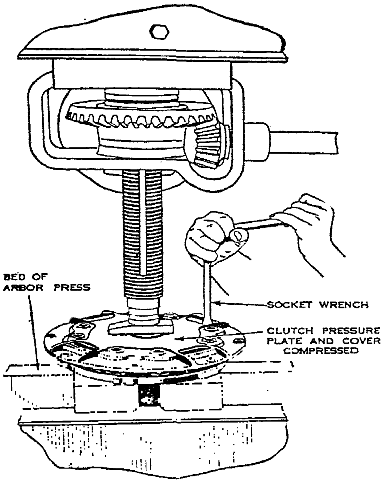


Fig. 14. Disassembling the Pressure Plate under the Arbor Press

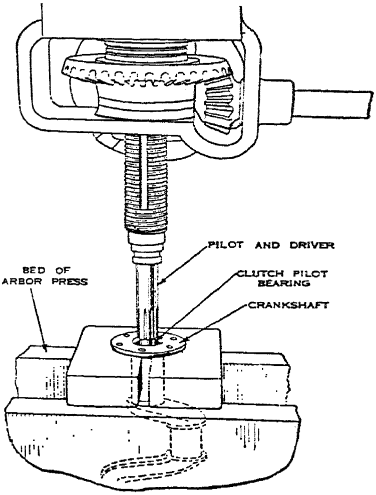


Fig. 15. When Reassembling the Chevrolet Clutch, a Pilot Is Used as a Clutch Plate Aligning Tool

If it is desired to disassemble the cover pressure plate, it is necessary to place the clutch cover which has been removed from the flywheel in an arbor press, as illustrated in Fig. 14, in order to compress the clutch springs. Remove the four pairs of cap screws which fasten the clutch pressure plate to the clutch cover. Then release the springs by releasing the arbor press or other means used in compressing the springs. Reverse this method when reassembling the clutch.

Inspecting for Repairs. When the clutch has been completely disassembled, go over all the parts for evidence of wear. Those parts in poor condition should be replaced with new ones. If the clutch has been slipping, thus causing the discs to heat it will be found that they have lost their wavy offset and cause grabbing. Should this condition arise, a new clutch driving disc, whose discs are properly shaped, should be installed or the old disc should be reformed by the use of a reforming die.

The clutch discs may be reformed for the correct wavy offset by the use of the clutch disc reforming fixture, shown in Fig. 15, by placing the fixture in a vise and dropping the clutch disc assembly into the fixture, letting the disc hub flange rest on the rounded portion of the fixture and rivets spaced between the top block at the rear of the fixture; then by closing the fixture tight between the jaws of the vise, the clutch disc will be reformed into its original shape, namely, with three waves.

The clutch friction rings or clutch disc may, on account of improper use, faulty adjustment of the clutch pedal, or after long service, start to slip. If the friction rings or disc have become worn and the clutch slips, replacement of the worn parts is the only remedy. Broken or weak clutch springs may also be responsible. If the clutch plates or parts after long use become worn to the point that the clutch does not function properly, renewal of the parts is the only remedy.

The clutch is so constructed that there is a minimum of wearing surface. However, if the clutch should show a tendency to rattle or chatter when released, the fit of the clutch disc hub on the spline shaft should be checked carefully. Examine the clutch springs to see that none is broken or too weak. This condition will be very rare. However, should this condition manifest itself, replacement of springs is the only remedy.

Releasing the Clutch. Place the clutch friction ring in the flywheel, then insert the clutch hub with disc, next the clutch friction ring, followed with the clutch pressure plate, and the clutch cover may be assembled to the flywheel. It is absolutely necessary to see that the slot in the clutch pressure plate, shown at *A* in Fig. 13, fits over the driving pins in the flywheel and that the holes in the clutch cover and flywheel line up. It should be noted that the clutch cover will go only in one position to line up properly with the cap screw holes in the flywheel. The driving pins in the flywheel must be in the slots on the pressure plate. One of these can always be seen through an elongated hole in the cover, though the others are not visible.

When replacing the clutch in the flywheel, the same care should be used in replacing the cap screws that was used when removing the clutch, that is, get the cap screws started and then turn each one up one-half turn at a time, thus bringing an even pressure all the way around against the resistance of the clutch springs until the clutch cover is firmly against the face of the flywheel.

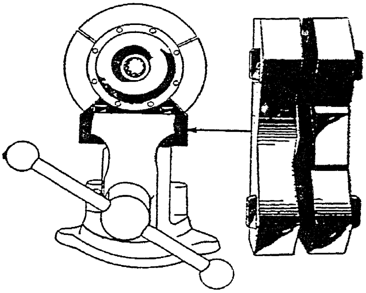


Fig. 16. Using a Form Tool to Reform the Clutch Disc

In reassembling the clutch, it is necessary that the various units be lined up properly. This can be readily accomplished by using a clutch pilot tool or main drive gear-shaft assembly to line up the clutch plate prior to installing the transmission. A special tool for this purpose, as shown in Fig. 16, can be made by cutting the gear from an old main drive shaft. The same tool for lining up the drive units of the clutch can also be used in pressing a new bushing in the end of the crank shaft which is used as a pilot for the front end of the main drive shaft, as illustrated in Fig. 17. Be absolutely sure the clutch throw-out bearing is properly seated and clamped firmly in the clutch collar. **Do not lubricate this bearing. Keep it free of grease or oil.**

Clutch Adjustment. Gradual wear on the throw-out bearing and other clutch parts will necessitate a clutch-pedal adjustment. Correcting pedal adjustment is a very simple operation. With the clutch fully engaged, the pedal should be at least ¾ inch from the floor board, as illustrated in Fig. 18. The clutch and brake pedal stop controls this distance and should be adjusted accordingly. The next operation is the adjustment of the clutch adjusting nut. This nut should be tightened or loosened so that, by depressing the pedal with the hand, it will travel from ½ inch to ¾ inch before the clutch starts to disengage, that is, the clutch pedal should clear the floor board by ¾ inch or more when against the clutch pedal stop, and the clutch adjusting nut should be so adjusted that the pedal can be depressed approximately ½ inch to ¾ inch before the clutch starts to disengage. Also, when the clutch is fully disengaged, the pedal pad must clear the floor board by not less than ¾ inch.

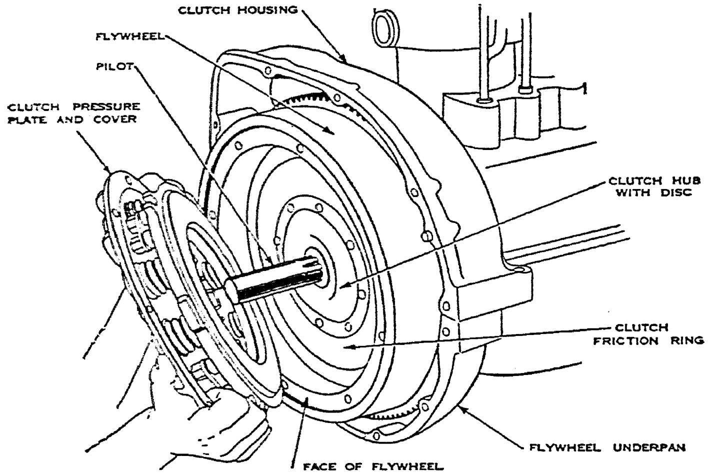


Fig. 17. Pressing a Pilot Bearing into the End of the Crank Shaft

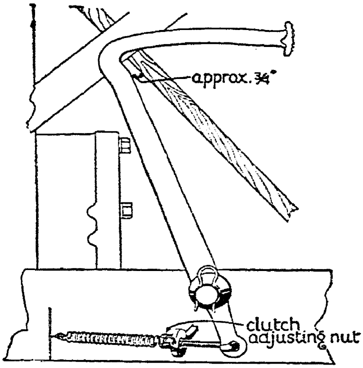


Fig. 18. Specifications for Clutch Adjustment

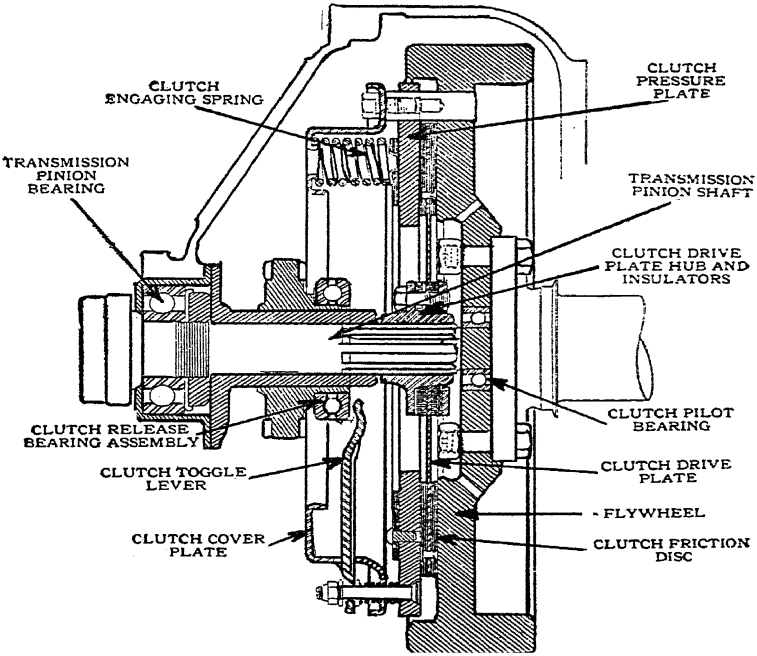


Fig. 19. Sectioned View of Studebaker Long Clutch

STUDEBAKER LONG CLUTCH

The clutch used in a number of the Studebaker models is of Long manufacture, being known to the trade as the Long clutch. The Long clutch is also used in a number of other automobiles. The Studebaker Company has used it in the "Standard Six," in the bus, in the "Big Six," in the "Commander," and in the "President." The clutch is of the single-plate design, although in the case of the "President Eight" an auxiliary driving plate with an additional driven plate is used, making it a two-plate clutch.

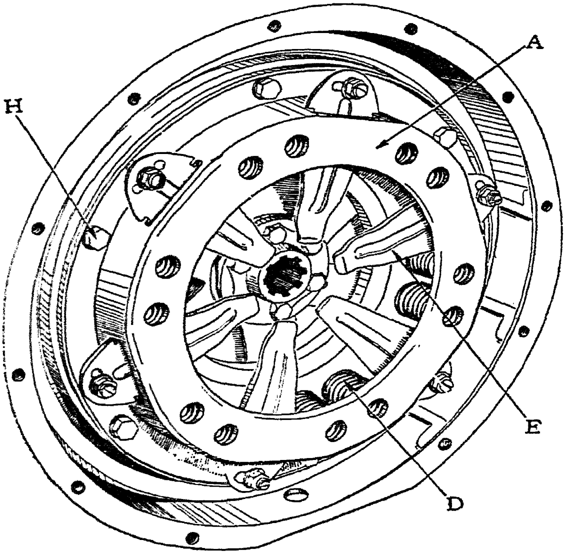


Fig. 20. Studebaker Long Clutch Assembled in Engine

Features of Design. A cross section of the Long clutch is shown in Fig. 19. It will be noted that it mounts on the flywheel similar to other single-plate clutches. The clutch release bearing assembly is actuated by a shifter shaft or yoke, shown at *E* in Fig. 23, which also shows the clutch release bearing at *B*. When this bearing is forced forward toward the engine flywheel by the action of the shifter shaft or yoke, the inner ends come in contact with six clutch toggle levers. These are named in Fig. 19 and are shown at *E* in Fig. 20, which shows a Long clutch assembly in the engine, and again at *E* in Fig. 21.

The action of the toggle lever serves to compress the clutch engaging springs, twelve in number, shown in the cross section Fig. 19 and at *D* in Figs. 20 and 21. These clutch engaging springs are in direct contact with the inner surface of the clutch pressure plate, Fig. 19, also shown at *A* in Figs. 20 and 21. The clutch pressure plate assembly, being rigidly bolted to the flywheel rim, is constantly turning with the flywheel when the engine is running. The pressure plate itself, while free to move inward or outward a short distance, turns with the flywheel so that any power transmitted to it by the flywheel is in turn transmitted to the clutch friction discs mounted on the clutch drive plate. When the car is being driven with the clutch in, part of the power is transmitted directly from the flywheel to the clutch friction disc and part from the inner surface of the clutch pressure plate.

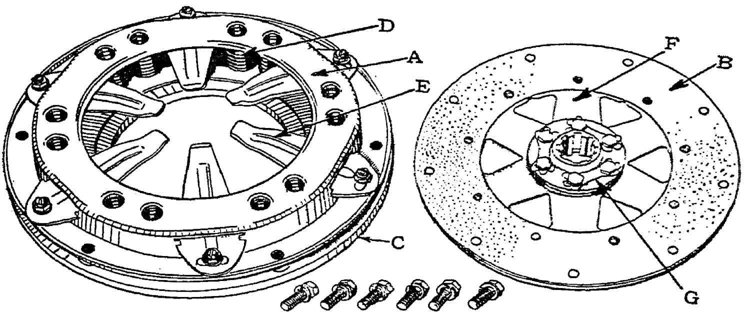


Fig. 21. Studebaker Long Clutch Disassembled

When the clutch is removed from the engine, the six cap screws *H*, Fig. 20 are run out, after which the clutch assembly may be lifted from the engine, Fig. 21, which also shows the single plate *E* with the clutch hub *G* bolted to it and the clutch facings *B* riveted to it. Repairs to the Long clutch are easily made. The pressure plate assembly is not designed to be repaired in the ordinary service station. If it fails, it is returned to the factory. The servicing of these clutches is very similar with reference to all models of the Studebaker cars fitted with them.

Servicing Studebaker "President Eight" Long Clutch. The adjustment of the Long clutch is comparatively simple; in fact, there is but one adjustment and that is an adjustment shown at *F* in Fig. 22. It controls the position of the pedal *D*. The action of the clutch is as follows. When the pedal *D* is depressed, power comes on to the head of the cap screw *F*, from which point it is transmitted through the lever *G* to the pin *F*, Fig. 23, at which point it is reversed and carried to the inner ends of the yoke, with the result that the clutch release bearing *B* is moved forward along the clutch shaft engaging with the six toggle levers.

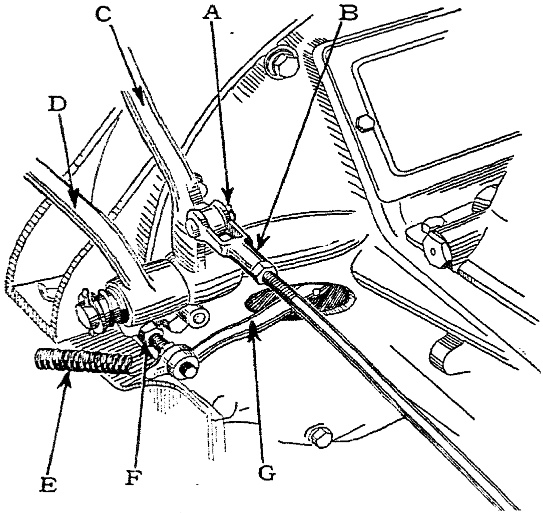


Fig. 22. Studebaker Clutch Pedal Adjustment
A—Brake Clevis Pin. *B*—Brake Clevis. *C*—Brake Pedal. *D*—Clutch Pedal. *E*—Clutch Yoke Return Spring. *F*—Clutch Adjusting Screw. *G*—Clutch Throw Out Yoke Lever.

Adjusting screw *F* controls the floor board clearance of the clutch pedal. The adjustment should be made so that the clutch pedal pad has one full inch of free movement before the clutch starts to release, after which the pedal-arm stop-screw nut should be locked securely. Next adjust the pedal pad so as to have 6 inches clearance between the toe board and the pedal pad. The action of the lower pedal-arm spring holds the pedal arm back to the toe board.

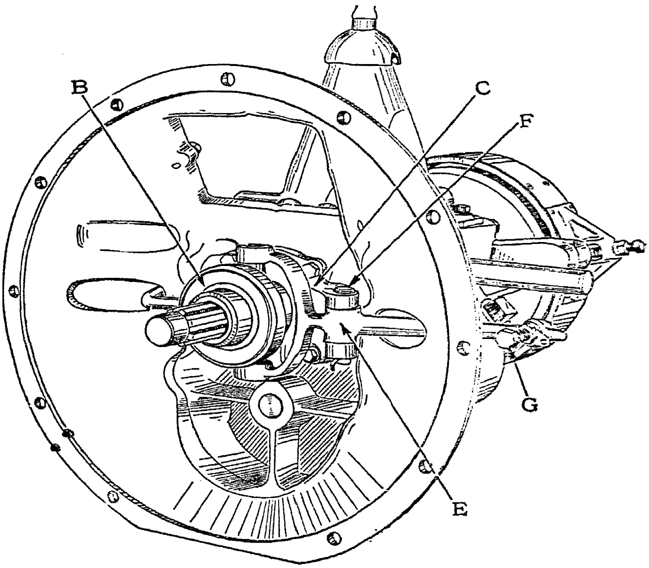


Fig. 23. Studebaker Transmission, Showing Clutch Shifter Shaft *E*, Release Bearing *B*, Yoke *C*, Lever Pin *F*, and Adjusting Screw *G*

Removing the Transmission. Whenever it is desired to remove the clutch for repairs, it is necessary to first remove the transmission assembly, Fig. 24. Remove the floor board mat. Take out the four screws and remove the hand control mat. Next remove the battery box floor cover. Unscrew the three screws and remove the large floor board. Unscrew the two screws and remove the small floor board. Unscrew the accelerator plunger and starter pedal. Take out the four screws holding the steering post mat in place and remove the mat. Remove the five large screws holding the toe board in place and remove the board. Remove the service brake clevis pin *F*, Fig. 25. Remove the cotter key, washer, and spring at *G* and remove the clutch and brake arms. Next remove the six bolts holding the rear universal joint to the rear companion flange. Unscrew the dust cap from the front joint and remove the propeller shaft. Disconnect the speedometer cable at the trans-

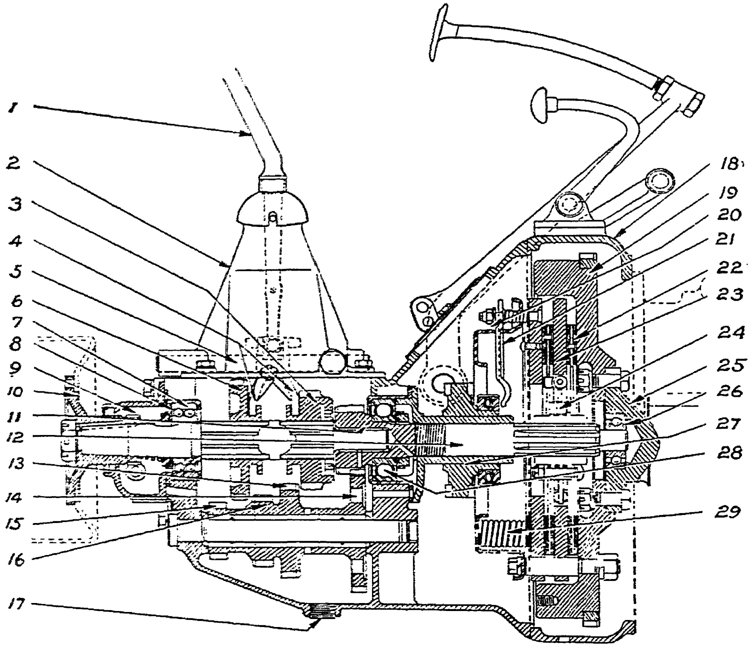


Fig. 24. Longitudinal Section through Studebaker "President Eight" Transmission and Clutch

1—Gear Shift Lever. 2—Gear Shift Base. 3—High and Intermediate Sliding Gear. 4—Gear Shift Forks. 5—Gear Shifting Fork Bars. 6—Low and Reverse Sliding Gear. 7—Transmission Shaft Rear Bearing. 8—Transmission Shaft Bearing Retainer. 9—Speedometer Drive Gear. 10—Transmission Shaft Flange. 11—Transmission Shaft Bushing. 12—Transmission Pinion Shaft. 13—Countershaft Intermediate Gear. 14—Countershaft Gear. 15—Countershaft Reverse Gear. 16—Countershaft Low Gear. 17—Transmission Oil Drain Plug. 18—Clutch and Flywheel Housing. 19—Flywheel. 20—Clutch Cover Plate Assembly. 21—Clutch Release Lever. 22—Clutch Driving Flange Assembly. 23—Secondary Driving Plate. 24—Spring Cushioned Splined Hub. 25—Crank Shaft Flange. 26—Clutch Pilot Bearing. 27—Clutch Shifter Bearing Assembly. 28—Pinion Shaft Bearing. 29—Clutch Pressure

mission. Disconnect the spring *H* from the clutch shifter arm. Take out the screws *K* holding the transmission to the flywheel housing. Care must be taken to support the transmission on a block or otherwise so that the transmission pinion shaft will not become sprung. The transmission can now be removed, carefully pulling it back and slightly to the side. Reverse these operations when replacing it.

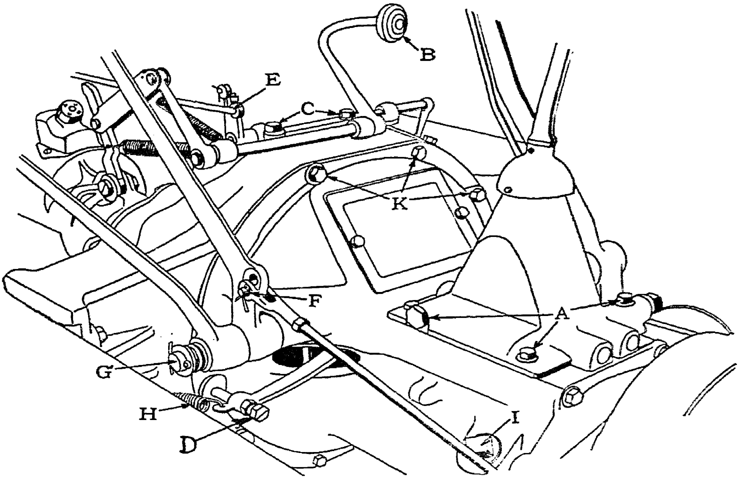


Fig. 25. Left-Hand Side of Studebaker "President Eight" Transmission in Chassis

Disassembling, Repairing and Reassembling Clutch. The Long clutch pressure plate should not be repaired. It should be returned to the factory or replaced with a new one. Clutch facings which have shown wear should be replaced. It is a good plan to inspect the clutch hub to see whether the splines show undue wear. If the clutch hub and clutch plate are in good condition, new clutch facings may be installed, otherwise a new unit with clutch facings in position would be indicated.

After the transmission has been removed, remove the six fastening screws *H*, Fig. 20, which hold the clutch assembly to the flywheel. Turn these screws out gradually so as to equalize the strain on the outer plate. The outer and inner plate and springs will come out as an assembly. Remove the clutch driving flange. If it is necessary to remove the clutch shaft pilot bearing, it can now be pulled out. Reverse the operations to replace. Be sure to pack the pilot bearing well with grease before replacing. When putting the clutch driving flange, Fig. 26, into place, it must be properly centered so that the flutes in the flange hub will line up with the pilot bearing when replacing the transmission assembly. Assemble with the flat springs *A* next to the flywheel. After replacing the flange, put a clutch driving flange aligning arbor through the flange hub so that the pilot on the arbor enters the pilot bearing in the crank shaft. Then replace the outer clutch assembly, tightening the screws gradually and equally so as to strain the plate.

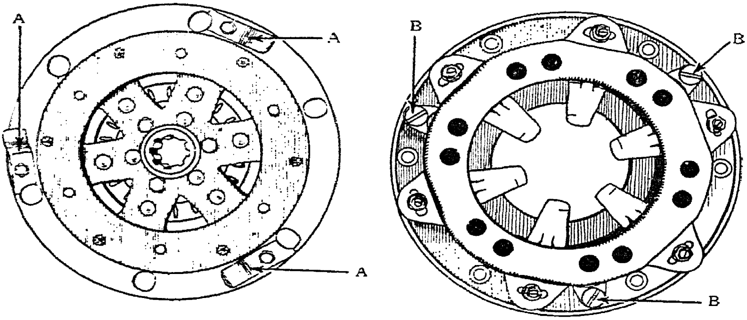


Fig. 26. Studebaker "President Eight" Clutch Disassembled

Before the cover plate assembly is mounted on the flywheel, the three driving plate adjusting screws, *B*, Fig. 26, must be backed off until their ends are flush with the face of the pressure plate. After the cover plate is installed, turn the screws forward as far as possible and then back off four notches to prevent dragging of the clutch in the released position. Remove the aligning arbor and reassemble the transmission to the car.

The only adjustment to be made on this style of clutch is the pedal adjustment. Loosen the clutch pedal arm lower stop screw lock nut and adjust the stop screw *D*, as shown in Fig. 25, so that the pedal pad has one full inch of free movement before the clutch starts to release. Lock the pedal arm stop screw nut. Adjust the pedal pad to have a 6-inch clearance between the toe board and pedal pad. The lower pedal arm spring will hold the pedal arm back to the toe board.

CADILLAC-LA SALLE TWO-PLATE CLUTCH

The construction of the two-plate Cadillac-LaSalle clutch is very similar to that of a number of other plate clutches where a single plate is used. The clutch discs are lined with facings on each side of each disc, as illustrated in Fig. 27. These discs, Fig. 28, are carried on the clutch disc hub, Fig. 29, to which they are bolted. When the clutch is in, the pressure from the pressure plate assembly forces the center plate and the rear plate, which are carried in the flywheel, together, placing friction on the friction lining, so that the power from the engine is transmitted from the flywheel through the driving plates to the clutch discs, through the clutch disc hub, to the forward end of the main gear transmission or clutch shaft, as will be noted

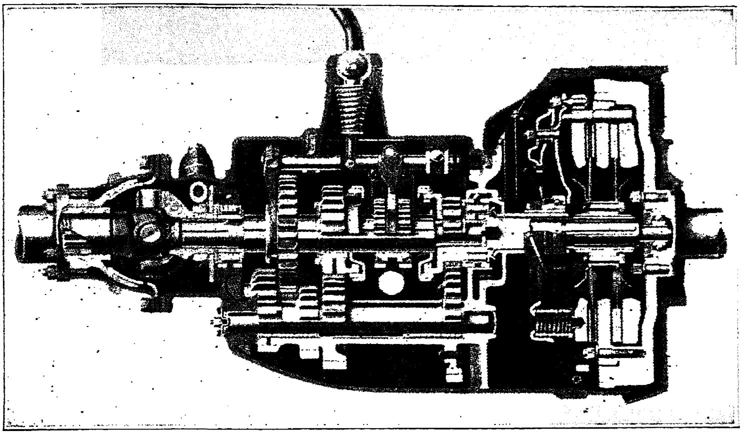


Fig. 27. Sectional View of Two-Plate Clutch and Transmission Used on Cadillac Cars

in the sectional view of the transmission and clutch assembly, thence to the main drive gear, from which point the power is distributed and used, depending upon the gear selected.

Pressure Plate Assembly. Twelve springs are used in this assembly. They are arranged in four groups of three each. When the clutch pedal is depressed, the clutch throw-out collar is forced forward on the clutch shaft and thus engages the inner ends of the four heavy release fingers or levers. This action compresses the twelve clutch springs, with the result that pressure on the clutch plates and clutch discs is released, and so the clutch driving action is released.

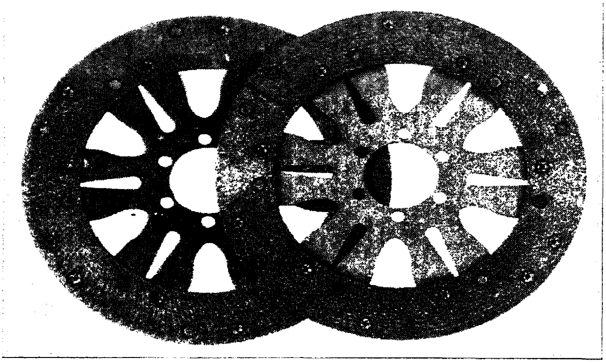


Fig. 28. Cadillac Clutch Plates

Cover Plate. A special cover on the clutch housing is designed to act as a ventilator. Considerable heat is generated in a clutch when the friction discs are slipped, as is necessary when starting a car with a load or when shifting gears. The clutch itself acts as a blower and tends to draw the air from around the hub and throw it off at the outside, thus setting up a pressure vacuum near the hub. Wherever this situation exists, there is a tendency to draw the transmission grease or lubricant through the space toward the clutch connections and the sleeve on which the release bearing slides. In order to overcome this tendency, Cadillac engineers have designed the cover plate with a duct extending down to a point near the release bearing, which admits air to the mechanism near the clutch hub, thus relieving this partial vacuum and overcoming the tendency to draw the lubricant from the transmission into the clutch compartment, where it might cause trouble.

Servicing the Clutch. Check the clutch pedal adjustment each thousand miles to see that the proper amount of free travel is available. When the car is new, the free travel of the pedal should be 1⅛ inches to 1¼ inches. After the first three thousand miles, the adjustment may be a trifle closer and may vary between 1 inch and 1⅛ inches. When replacing the clutch discs, which is the one service operation ordinarily performed on these clutches, the transmission must be pulled from the engine; after which the clutch may be released from the flywheel by removing the four nuts indicated by the four arrows in Fig. 30.

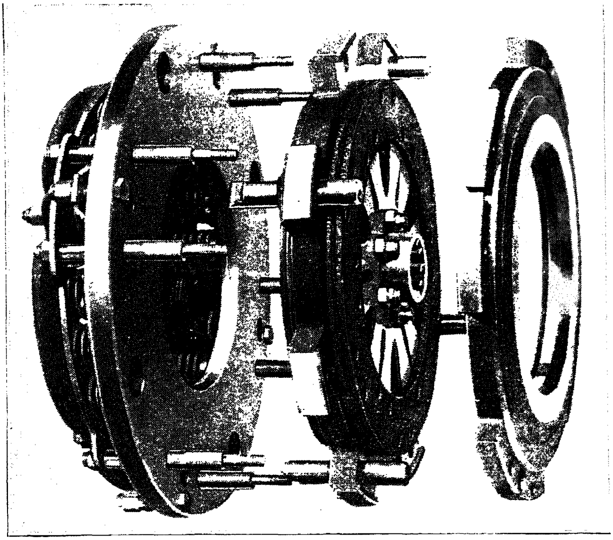


Fig. 29. Clutch Disc Hub

FORD MODEL "A" CLUTCHES

The first series of the Ford Model "A" cars carried a multiple-disc clutch. After some months, the multiple-disc clutch was discontinued and since that time the single-plate clutch has been used. Very little is to be said with reference to the relative merits of the two types of clutches, since either one is satisfactory.

Ford Model "A" Multiple-Disc Clutch. This clutch is of the dry plate type, as will be seen by referring to Fig. 31. There are five of the driven discs, which are plain discs of saw steel type construction. There are four discs which are known as the driving discs, and these are lined with an asbestos composition, two facings being riveted to one disc. The driven discs have serrations or teeth on the inner diameter and are designed to fit on teeth milled on the clutch disc drum. The clutch disc drum in turn is splined to the clutch shaft, so that the power which is delivered from the flywheel is transmitted through the driving discs, which are fitted to the flywheel by means of teeth, and then from the driving discs to the driven discs,

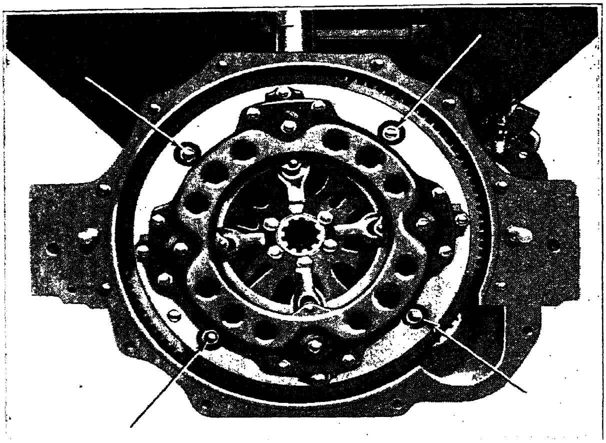


Fig. 30. To Remove the Cadillac Clutch from the Engine, Remove the Four Nuts Indicated by the Long Arrows

thence to the clutch disc drum, thence to the clutch shaft and transmission.

A single coil spring is used to compress the clutch plates and hold them together in order that the power may be transmitted. The release fork is used to release this spring pressure when the clutch pedal is pushed down. The release fork, shown in Fig. 31, is mounted to the clutch pedal shaft. The upper ends of the fork are in contact with a ball bearing, known as the release bearing.

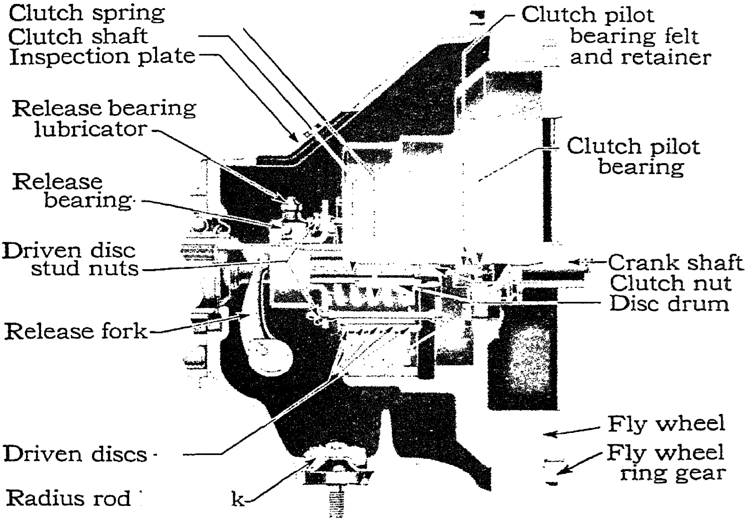


Fig. 31. Multiple Disc Clutch Used on First Series Model "A" Ford Cars

Adjusting Clutch Pedal to Toe Board. The clutch pedal is designed to have approximately ¾-inch free movement under the floor board before the clutch actually starts to release. This is a precaution taken in order that when the clutch is in the "in position" place, there is no danger of it slipping. It will be seen that if the driver of the car should rest his foot on the clutch pedal continuously or if the clutch has become worn to a point where the ¾-inch play below the toe board had become exhausted, then there would be a continuous tendency or pressure to release the tension of the clutch spring, with the result that clutch slipping might occur. If clutch slipping does occur,

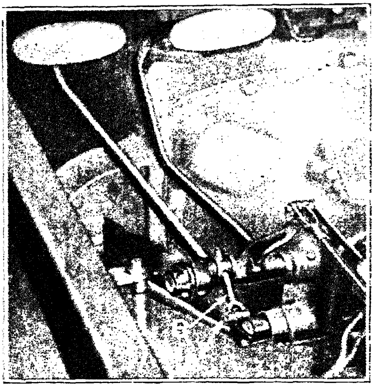


Fig. 32. Clutch Adjusting Arrangement on Ford Model "A" Cars

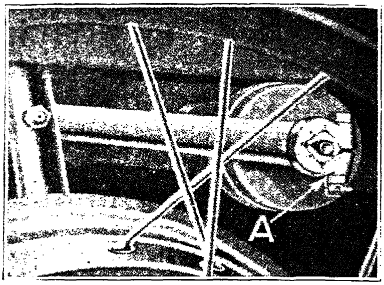


Fig. 33. Houdaille Shock Absorber Arm Clamp Bolt

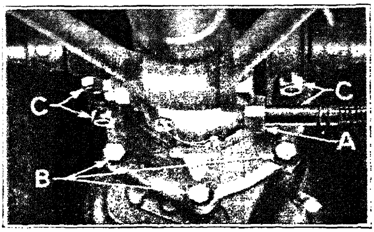


Fig. 34. Universal Joint and Torque Assembly

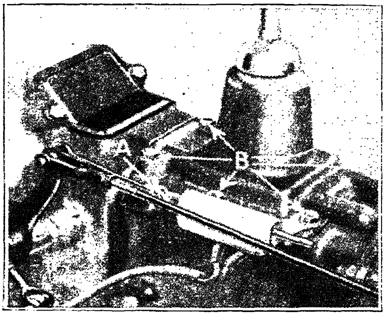


Fig. 35. Stop Light Switch and Transmission Cover Assembly

the clutch plates are likely to be warped from the heat.

When making the adjustment of the clutch pedal with reference to the toe board, the cotter pin *A*, Fig. 32, should be removed and the clevis pin pulled, after which the adjustment is made by turning the rod *B* in or out as required to secure the normal setting of $\frac{3}{4}$-inch clearance.

Removing the Ford Clutch. When removing the clutch, it is necessary to drop the transmission. In order to drop the transmission, it will be found that it is necessary to pull the rear axle from the car, or at least take the weight from the rear of the car, and drop the rear assembly—loosen and pull it backward. This means that the shock absorber arms will need to be disconnected at *A*, Fig. 33. The spring hangers should be removed. The rear brake rods are disconnected at the rear cross shaft. The forward floor board and mat are removed, and the battery is pulled. Remove the speedometer cable at the drive cap *A*, Fig. 34, and then having the car properly raised at the rear so as to have the axle free, screw out the six universal joint housing cap-to-transmission bolts and nuts *B*, and the four universal housing bolts *C*, after which the upper and lower half of the universal joint housing cap may be removed and the rear axle assembly moved backward.

Next lift off the universal joint housing inner cap and disconnect the front radius rod from the bottom of the transmission case or clutch housing. See that the stop light switch wires are disconnected. Remove the gear shifter housing which is held on by means of six screws *B*, Fig. 35. Remove the eleven clutch housing screws where the transmission is bolted to the engine. The transmission and clutch housing assembly may now be pulled backward and dropped to the floor.

Installing Transmission and Clutch in Car.[*] Make a careful inspection to see that all parts are in proper order. Pay particular attention to the internal teeth of the flywheel, using a wire brush or other means to clean them thoroughly. The particles worn from the old clutch facing may have lodged in them. Block the radius rod point by placing a wood block between the radius rod and the bottom of the flywheel housing. Use a teaspoonful of vaseline or high-grade cup grease to lubricate the bearing in the flywheel. Install the clutch transmission assembly by raising it from the floor and blocking it at the proper height. Line up the clutch discs and the internal teeth of the flywheel, after which the clutch is slipped forward until the clutch housing and flywheel housing come together. Run in the clutch housing screws. If the two housings do not come together, do not force them but find where the trouble is and adjust it.

---

[*] Note: Except a small number of early model Ford "A" cars the Model "A," Model "B," and "V-8" Models have used a clutch of the Long type and the detailed instructions given for that clutch in the preceding paragraphs apply to the Ford clutch as well.

Next remove the inspection plate of the clutch housing to see whether the parts are properly assembled. Press the clutch pedal all the way down and then, with a pencil or small tool, press in on the rear clutch disc, which is the one with the slotted tooth, and note whether it is binding on the internal teeth of the flywheel. If this is found O.K., proceed with the reassembling of all the other parts which have been removed, finally inserting the transmission cover and gear-shift housing. When installing this, be very careful to have the gear-shift lever in neutral position, and see that the transmission gears on the main transmission gear shaft are so spaced that the gear shifter forks line up and enter the sliding gear collars. See *A*, Fig. 36. Use extreme care in checking over to see that all parts which were removed in order to get at the transmission and clutch are properly checked up and reassembled, applying grease or oil for lubrication as the several parts may need.

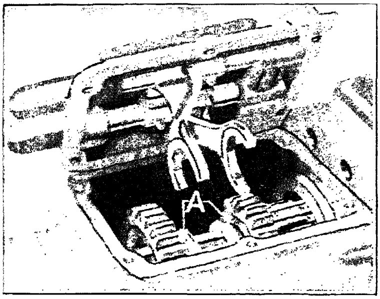


Fig. 36. Lining up the Gears and Installing the Transmission Cover

Ford Model "A" and "V-8" Single-Plate Clutch. This clutch is illustrated in Fig. 37. It will be noted that the clutch release has been changed along with the general assembly and other constructional details. There are two major units of the single-plate clutch and these are known as the cover plate assembly and the clutch disc assembly.

The cover plate assembly consists of a cast-iron outer driving plate and a stamped cover plate in which are mounted the twelve pressure springs and six release levers. These springs are in direct action against the pressure plate and automatically compensate them for wear of the two friction facings. No provision for adjusting the release levers is made.

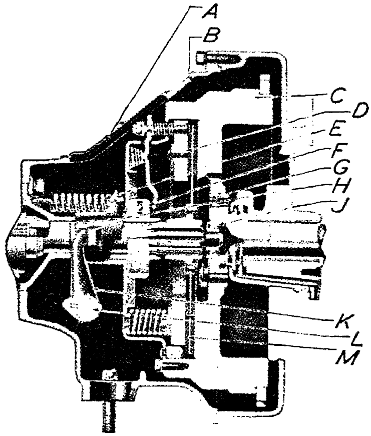


Fig. 37. Ford Model "A" Single-Plate Clutch in Cross Section View

A—Clutch Housing Handhole Cover. *B*—Clutch Housing Assembly. *C*—Flywheel Assembly. *D*—Pressure Plate and Cover Assembly. *E*—Release Bearing Spring. *F*—Release Bearing Assembly. *G*—Flywheel Dowel Retainer. *H*—Release Bearing Hub. *J*—Clutch Pilot Bearing. *K*—Release Shaft Fork. *L*—Clutch Release Shaft. *M*—Clutch Disc Assembly.

The clutch disc assembly, which is the driven member, is composed of a flat steel disc and the two friction facings or clutch linings. These facings are riveted to the driven disc. In order to secure a smooth action when the clutch is being engaged, the driven disc is constructed with a dished or cone effect, so that the outer and inner edge of the facings start to engage first and, as the clutch pedal is allowed to come in, more and more of the facing comes into contact in a gradual manner until finally when the clutch is fully in, all of the surface is in contact.

NOTE. It is not recommended that any attempt be made to repair any of the parts of the pressure plate and cover assembly, since special jigs are required to set these up, and an attractive exchange price exists.

Servicing Single-Plate Clutch. Under no circumstances attempt to adjust the release levers. The only adjustment for clutch wear is made at the bottom of the clutch pedal. This clutch pedal must have 1-inch free play or movement before it starts to engage the clutch.

The chattering or slipping of the clutch at high speeds is usually caused by grease on the clutch friction facings or the abuse of the clutch such as might occur if the 1-inch free movement of the pedal is not maintained. When the clutch discs have become troublesome, the proper remedy is to remove the transmission and clutch housing and then replace the clutch facings. This work may be done in any shop, due care being used to see that the rivets are properly set up.

If on an inspection of the clutch parts it is found that the clutch pressure plate has developed small radial heat cracks or that the pressure plate is grooved or scored, all that will be necessary will be to polish up the face, after which the unit may be replaced as the small cracks will do no harm. These small cracks are heat checks.

Removing and Reassembling Single-Plate Clutch. Outside of the actual removing of the clutch plates, the work is similar to that outlined for removing and replacing the transmission and clutch assembly. In the case of the single-plate clutch, the main difference is that the clutch does not pull away from the flywheel when the transmission is removed. After the transmission has been removed, it will be found that the cover plate assembly will need to be removed from the flywheel by releasing the cap screws holding it to the flywheel rim, after which it will be found that the driven member or clutch disc assembly may be lifted out.

When replacing these units, it will be found that it is absolutely necessary to line up the clutch discs or this inner assembly with the outer assembly, otherwise the clutch shaft will not properly engage. The best way to do this work is to make use of either a new or old transmission main drive gear, as illustrated in Fig. 38. The small end of this shaft acts as a pilot to align the parts with the pilot bearing in the flywheel, while the splines on the shaft mesh with the splines in the hub of the disc and hold the disc in accurate alignment when the clutch pressure assembly is being installed. After the clutch pressure assembly has been bolted to the flywheel, the pressure on it will hold the clutch disc in position while assembling the transmission and clutch housing and lining up the clutch shaft with the flywheel assembly.

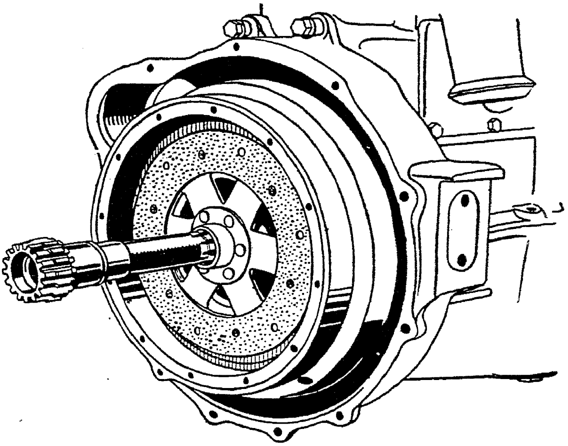


Fig. 38. Using a Clutch Shaft to Align the Clutch Parts with the Pilot Bearing

Power Clutches. These units are air cylinders with a piston designed to be operated by the suction of the engine. Their operation is similar to the action of the vacuum-operated power brakes. Fig. 39 illustrates an engine with a power-clutch unit connected to the right side. Note the vacuum line running from the rear of the cylinder to the intake manifold. In this application the clutch shaft has been extended through the transmission bell housing, and the lever operated by the power clutch cylinder is connected to this extended shaft. A valve controlling the application of the vacuum power is just above the cylinder. Details of the operation of this type of equipment are given in connection with the Buick installation.

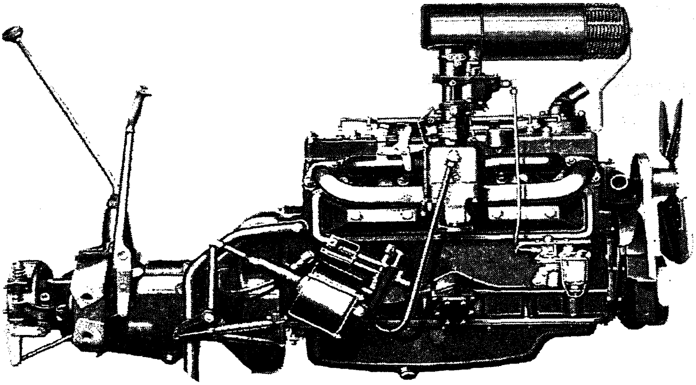


Fig. 39. Power Unit as Applied to an Engine and Clutch

BUICK POWER-OPERATED CLUTCH

The 1932-33 Buick vacuum- or power-operated clutch provides automatic clutch operation for both gear shifting and free wheeling without the use of special over-running clutches or other mechanisms in the transmission. This device consists of a piston and cylinder connected to the clutch release mechanism and is operated by the vacuum from the intake manifold. The vacuum is controlled through valves connected to a control button on the toe board and to the accelerator pedal. The design is such as to vary the speed of engagement of the clutch according to the speed with which the accelerator pedal is depressed.

The relative position of the clutch control parts is shown in Fig. 40. The vacuum or power cylinder is attached to the side of the transmission, and the piston is connected to the clutch release mechanism. The power cylinder is connected to the clutch release mechanism, and also it is connected through a control valve to the intake manifold, which furnishes the necessary vacuum. Although the power cylinder is connected to the clutch pedal, it does not interfere with the pedal action, and the clutch may be operated manually entirely independent of the automatic control.

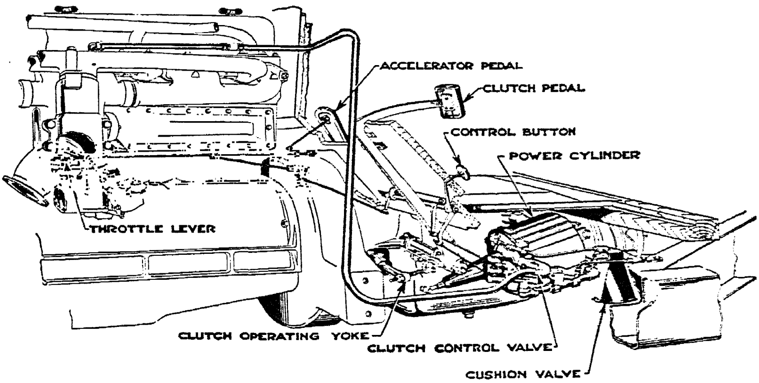


Fig. 40. Power-Operated Clutch System

Power Cylinder. The power cylinder has a conventional piston which divides the housing into two chambers. The front or air chamber is open to the atmosphere through three passages. The first is the air by-pass in the piston rod. The second is the atmospheric valve in the cylinder head. The third is the bleeder line leading to the bleeder valve in the control valve unit. The rear or vacuum chamber is connected to the intake manifold vacuum line through the cut-out and accelerator plungers in the control valve.

The air by-pass in the piston rod is two milled slots. Its operation is controlled by the movement of the piston and permits a rapid discharge of air from the air chamber when the piston is moving forward up to the point at which the clutch begins to engage. After this point is reached, the only escape for air from the air chamber is through the bleeder plunger in the control valve. The air valve in the cylinder head permits a rapid refilling of the air chamber in the cylinder when the clutch is being disengaged.

Control Valve. The control valve, Fig. 41, contains three plungers—the bleeder plunger, the accelerator plunger, and the cut-out plunger. The bleeder and accelerator plungers are inter-connected to the accelerator pedal. Their operation is positive in both directions. The cut-out plunger is operated in one direction by the control button and its return movement is accomplished by means of a spring.

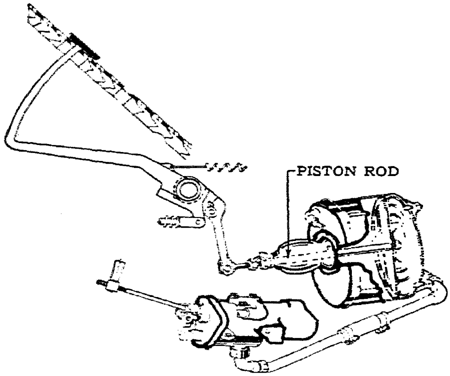


Fig. 41. Cylinder Cutaway to Show Piston Control Valve Below

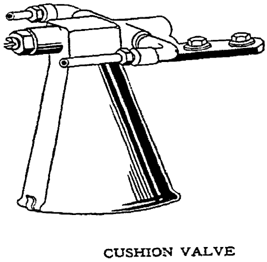


Fig. 42. Cushion Valve

The control valve, taken into conjunction with the cushion valve, serves to assure the operator trouble-free clutch action.

Cushion Valve. An inertia-controlled cushion valve, Fig. 42, is located between the air chamber in the power cylinder and the air bleeder plunger in the control valve. It consists of a sliding valve operated by a pendulum which is actuated by

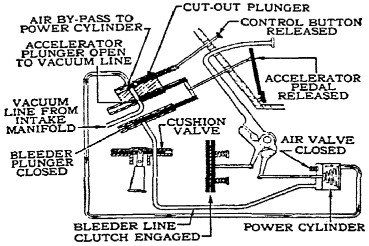


Fig. 43. Clutch Engaged

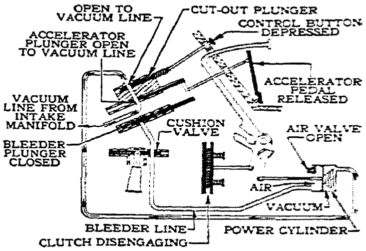


Fig. 44. Clutch Starting to Disengage

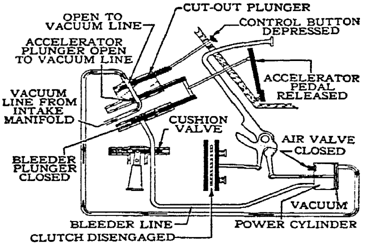


Fig. 45. Clutch Disengaged

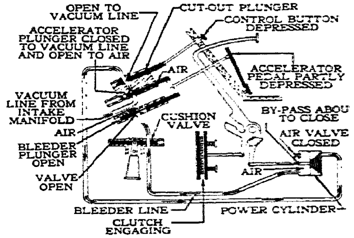


Fig. 46. Clutch Starting to Engage

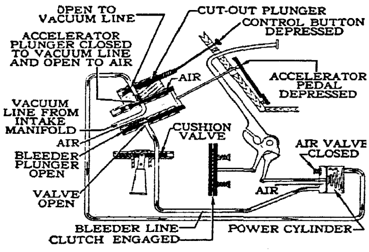


Fig. 47. Clutch Engaged

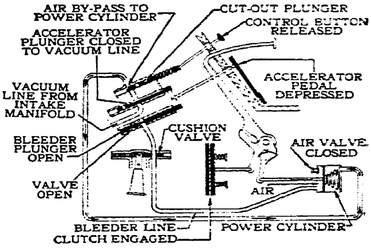


Fig. 48. Clutch Engaged

sudden acceleration or deceleration of the car. This valve interrupts the escape of air from the power cylinder, momentarily holding the clutch in partial engagement. This assures smooth "pick-up" when the accelerator pedal is suddenly depressed.

Sequence of Operations of Vacuum Clutch Control. The influence of the control valve on the clutch action is best described in the sequence of operations as shown in Figs. 43 to 49. In Fig. 43 the control button and accelerator are both released and the clutch is engaged. It will be seen that the bleeder line is closed by the bleeder plunger and the vacuum line by the cut-out plunger. The vacuum chamber in the power cylinder is open to the atmosphere through the by-pass in the cut-out plunger.

In Fig. 44 the control button has been depressed, opening the vacuum line, and the clutch has started to disengage. Air is flowing into the air chamber of the power cylinder through the air valve. The bleeder line is closed by the bleeder plunger.

Fig. 45 shows the clutch fully disengaged. The plungers in the control valve are in the same position as in Fig. 44, with the vacuum line open.

In Fig. 46 the control button is still depressed and the accelerator is being depressed to engage the clutch. The accelerator plunger has closed the vacuum line and has opened the vacuum chamber to the atmosphere. The bleeder plunger has opened the air chamber to the atmosphere. The by-pass in the piston rod has reached the cylinder head and is closed so that the only escape for the air in the air chamber is through the bleeder line. The speed at which the clutch engages depends upon the distance the bleeder plunger is pushed into the valve body.

Fig. 47 shows the clutch fully engaged with both the control button and the accelerator depressed. Both chambers of the power cylinder are open to the atmosphere and the piston is held forward by the pressure of the clutch springs and the spring inside the cylinder.

In Fig. 48 the control button is released, with the accelerator depressed and the clutch engaged. With the control button in this position, both chambers of the power cylinder are open to the atmosphere, and the movement of the accelerator has no effect on the operation of the clutch.

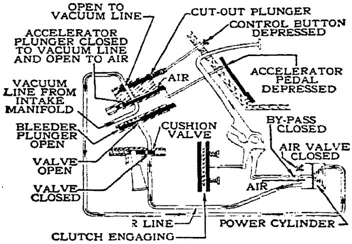


Fig. 49. Clutch Engaging

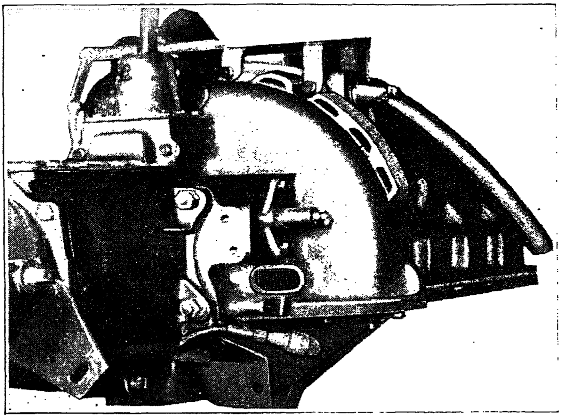


Fig. 50. Ventilated Clutch Housing in 1935 Chrysler Cars

In Fig. 49 the control button has been fully depressed, and the accelerator suddenly depressed to part or full throttle opening. Under this condition the clutch engages just enough to start the car moving, at which time the cushion valve comes into action.

Ventilated Clutch Housing. Friction, heat, power, and cooling are items which are closely tied together in any automotive design. Continuous use of a clutch results in the generation of considerable heat. Sometimes this has resulted in deterioration of the parts. Fig. 50 illustrates the transmission and clutch housing of the 1935 Chrysler. There is a screened opening. Air is drawn through the clutch housing and through the clutch mechanism at the rate of 600 cubic feet per minute at normal driving speed. This air flow through the housing is made possible because the main pressure plate of the clutch is ribbed so that it becomes in effect a fan which draws air. Ventilation of the clutch housing prevents excessive heat, which in the past has caused some burned-out clutches and loss of temper in the clutch springs. Incidentally the amount of pressure required to operate the 1935 Chrysler clutch is reduced approximately 30 per cent.

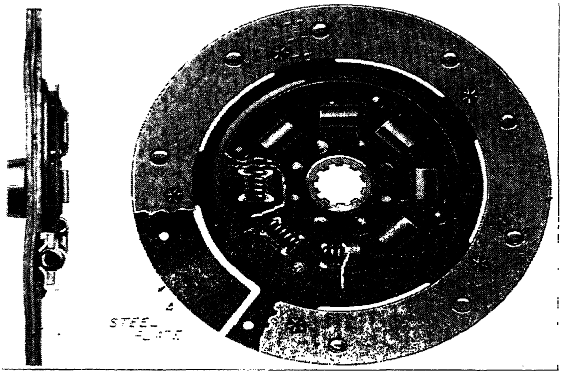


Fig. 51. 1935 Chevrolet Clutch Driven Plate

Waved Clutch Plates. The 1935 Chevrolet makes use of the waved clutch plates shown in Fig. 51. The view of the face of the clutch shows that there are five of these waved clutch sections to which the lining has been riveted. Part of the lining is left off at position *A*, to illustrate the section of the steel plate. The view of the clutch plate at the left shows an edge view in which the waving of the steel plate can be easily detected. Note that the lining on the one side closely follows this and on the other side it is somewhat free. The method of slanting the steel plate allows for expansion of the plate under heat and as the wave is straightened out without distortion of the next section. The lining used on this type of clutch is somewhat harder than that used on the flat type of driving plate. This insures greater life.

When this clutch is engaged, the high point on the facing is contacted first; and, since there are five of these, the application is around the circumference of the clutch, and a smooth gradual engagement of the load is secured. This serves to prevent chattering.

The clutch collar and clutch throw-out mechanism hooked up to the bottom of the clutch pedal by means of a two-link case-hardened chain, Fig. 52, has the advantage of serving to

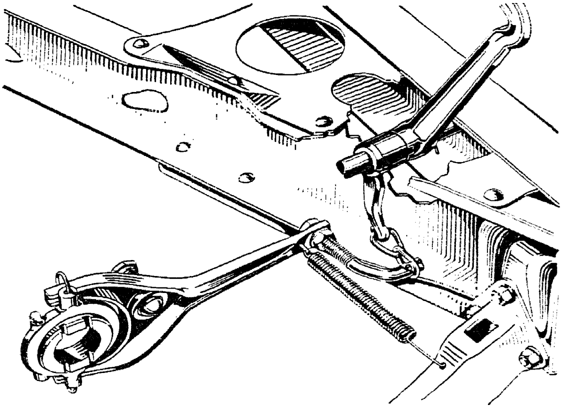


Fig. 52. 1935 Chevrolet Clutch Throw-out

reduce friction to a very low point and maintain pedal pressure practically at the same point throughout the life of the clutch facings.

Ford "V-8" Clutch. Ease of control is assisted by the 1935 type clutch, Fig. 53, in which centrifugal force is utilized to supplement the normal spring pressure. At idling and gear changing speeds (up to 750 revolutions per minute), the pedal pressure is reduced approximately 15 per cent; as the engine speed increases, clutch pressure increases until, at 4000 revolutions per minute, it is greater than previous models at any speed range. Needle bearings are used on the pressure plate mounting pins and the throw-out lever swivel pins have a roller action as additional means of obtaining smooth clutch operation. The pressure plate is machine-turned and polished. In balancing the plate, metal is removed from the bosses to avoid changing its cross-section. The clutch disc is fitted with a mechanical dampener of the spring and friction type to eliminate noise due to synchronization of vibrations in the drive system. Eight springs, which are prevented from becoming overstressed by four stop pins, cushion the load in either direction. The friction necessary to dampen out torsional vibration is obtained by eight friction washers, four on each side

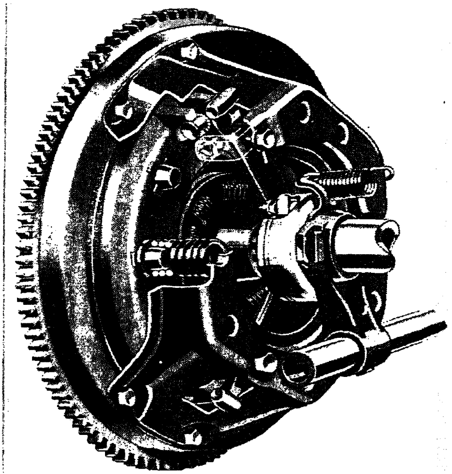


Fig. 53. 1935 Ford "V-8" (Centrifugal) Clutch

of the hub flange, under an adjustable spring load. The disc itself is slotted radially to relieve rim tension and provide flexibility. The cover plate stamping is triangular with legs extending to their points of attachment on the flywheel. This arch construction is rigid and provides ventilation for the pressure plate. The pressure springs are set on asbestos base insulator washers where they rest on the pressure plate to prevent excessive "set" of the springs under extreme heat conditions. The clutch throw-out bearing is of the pre-lubricated type designed to require no lubricant during the life of the car.

Buick Clutch Repair. The Buick clutches are of the single dry disc type. The clutch plates, Figs. 54 and 55, are fitted with a spring dampening device between the driven disc and the clutch hub. This device dampens out engine vibration periods and prevents them from being transmitted to the transmission by way of the clutch, where they would cause noise.

The Buick Co. advises that no attempt should be made to renew the springs in the clutch driven plate hub dampening device, and no change should be made in the dampening by the re-adjustment of the frictional nut of the clutch driven plate on the 60-80-90 Series.

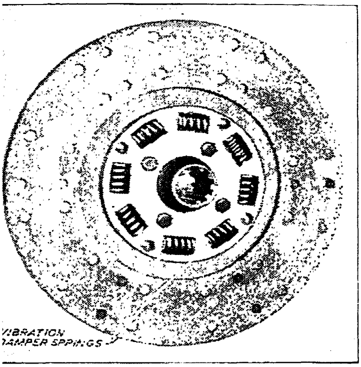


Fig. 54. Buick Clutch Plate with Vibration Dampener Springs — Transmission Side
Courtesy of Buick Motor Company, Flint, Michigan

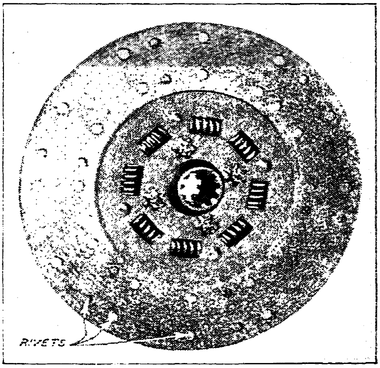


Fig. 55. Buick Clutch Plate with Vibration Dampener Springs — Fly-wheel Side
Courtesy of Buick Motor Company, Flint, Michigan

Great care must be taken when removing or replacing the transmission, not to distort the driven plates. This would cause the clutch not to release properly. The rear end of the transmission must be properly supported to hold the transmission, the clutch parts, and shaft in correct alignment until the clutch shaft is entirely clear of the driven plates.

If it is necessary to reline the clutch driven plates, Fig. 54, the removal and replacing of the facing must be carefully done, so as not to distort the disc. The rivets should be drilled and not punched out. New rivets should be rolled over and not split with the rolled head against the cushion spring. After relining the driven plate, it should be carefully balanced. The plate is balanced for static balance by placing it on an arbor which in turn is placed on knife edges. To balance the driven plate, the outer edge is ground away on the heavy side until the plate and arbor will rest in any position when placed on the knife edges, without revolving. If the driven plate is out of balance, the motor will not run smoothly. The only clutch adjustment for the Buick clutches is for the clutch-pedal lash distance. In the 40 Series, to increase the lash, shorten the clevis rod; to decrease the lash, lengthen the rod. One complete turn of the clevis changes the lash $\frac{7}{16}$ inch. The correct amount is within $\frac{3}{4}$ inch to 1 inch. On the 60-80-90 Series, the pedal lash should be $\frac{3}{4}$ inch to 1 inch. For every turn of the adjusting nut, the pedal lash changes $\frac{5}{16}$ inch. When the final lash adjustment is made, the pedal should be from $\frac{3}{8}$ inch to $\frac{5}{8}$ inch from the underside of the toe board.

Lincoln-Zephyr Clutch. The Lincoln-Zephyr clutch, similar to Ford V-8, Fig. 53, is of the dry type, single-plate, using a spring-type vibration damper in the hub of the driven member for quiet operation. The clutch pedal pressure is very light, being only 25 pounds at idling speed and 60 pounds at 4,000 revolutions per minute.

The release levers are weighted at one end and mounted on needle roller bearings. As the clutch revolves, centrifugal force increases the pressure on the driven member. At zero speed the pressure is 945 pounds, while at 4,000 revolutions per minute the pressure is 2,350 pounds. The centrifugal force set up by the weighted levers because of rotation, allows the light pedal pressure which is much easier on the leg muscles of the driver and on the moving parts when the clutch is disengaged.

CAR FRAME TYPES

FRAME TROUBLES AND REPAIRS

Early Construction. The car frame practically is the foundation of a motor vehicle, since all of the other units are attached to it. When the automobile was first introduced, comparatively little attention was paid to the frame. The other components of the chassis, such as the power plant, gearset, axles, etc., were held to be of greater importance. The first types of automobile frames were made of wood, ash being the material used. The cross-members, used for the different-unit supports, were forged out of angle iron and bolted to the main frame. For light-car construction, steel tubing was used. The supporting brackets were bolted on the main frame and, in some cases, they were brazed to and made a part of the main frame. After experiencing considerable difficulty, however, due to accidents and other failures which were traced directly to poor-frame design, the automobile engineer found that it was possible to build a frame of great strength with less weight than the types heretofore produced.

The improvement in frame design is the result of the tendency to provide perfect alignment of the power plant, clutch, and gearset, making use of what is known as the unit-power plant on most models, while on some, particularly of the heavier type, flexible mounting of the units has been resorted to. The tendency is toward the use of a flexible mounting of all individual units, at least to some degree, in order to relieve them of the stresses brought about by frame weaving when the road wheels mount an obstacle on the road surface.

Classes of Frames. The most prominent types of frames, divided according to their use, are the pressed-steel frame, the structural frame, and the structural I-beam frame; the latter is confined to commercial cars. These classes may be subdivided according to the general construction and material, as well as to the distribution of the chassis units.

The wood frame or combinations of wood and metal frames are wholly a thing of the past, being found, with one or two exceptions, only on old cars. The steel frame may be constructed in the following shapes: channel, **L**-beam, angle, **T**, **Z**, tubing, flat plates, and combinations of any two or more of these. Other forms are possible. For example, the channel may be turned with the open side in or out, the two constructions being widely different; or the angle may have the corner down and out, down and in, up and out, or up and in. Similarly, the T-shape may be a solid T turned up or down, or it may be a hollow T-section with space between what might be called the two sides of the leg; this shape may be turned either up or down, while the Z-shape may be turned either horizontally or vertically. Many frames are constructed with the open end of the channel section turned in, and use is made of a steel underpan of flat section attached to the under side of the main frame. In several instances there is a tendency to make the frame of box section with a channel within another channel, the two being fastened together with rivets.

Another type of frame is that having a continuous section throughout. Others have a varying section. Thus, the ordinary steel frame of modified channel section may have a depth of perhaps 8 inches at the center, a width of upper flange of 2 inches, and a width of lower flange of 3 inches. A frame similar to this would taper down to the ends to perhaps 3 inches in vertical height, and to 1½ inches in width of both top and bottom flanges. Then, again, frames which are bent upward or downward at the ends or in the middle really differ from those frames which preserve one level from end to end. Bending the car frame has become common practice, the upturning of the ends bringing about a lower center of gravity, thus making for stability to the body as well as ease of entrance and exit.

Tendency in Design. There is a marked tendency toward making the car frame wider at the rear and narrower at the front. The narrow front construction enables the car to be turned in a shorter radius and the wide rear frame provides more space to support a wider body. By widening the frame at the rear, it makes possible the placing of the springs directly underneath the frame. One satisfactory development is to make the longitudinal bars of the frame parallel over the front spring and near the rear spring, and to have them tapered from behind the front to the rear springs. A certain amount of material is said to be gained by this construction, as no heavy reinforcement or sudden offset is necessary to the frame.

Fig. 1 illustrates what is termed a single drop or a kick-up. This is a type of pressed-steel construction, of channel section, and the deepest and strongest section is at the center where the greatest stresses occur. Some frames are built with a double drop, Fig. 2, having a downward bend just forward of the entrance to the rear part of the car body, followed by an upward turn just back of the same entrance. The upward turn at the back is carried higher than the main part of the frame for the purpose of obtaining a low center of gravity. The frame shown in Fig. 2 compensates for an abnormal rise of the rear axle without the possibility of its striking the frame. Some frames have a bend at the ends to take the spring fastenings.

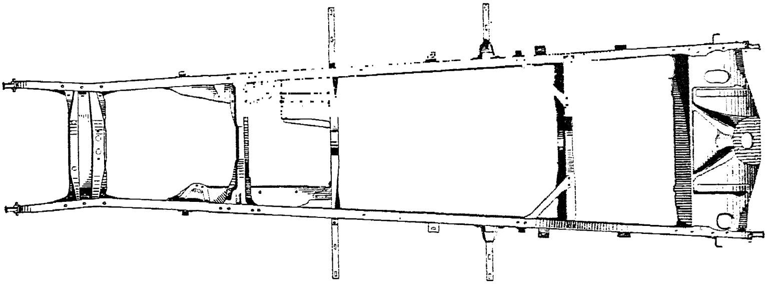


Fig. 1. Typical Automobile Frame of Pressed Steel

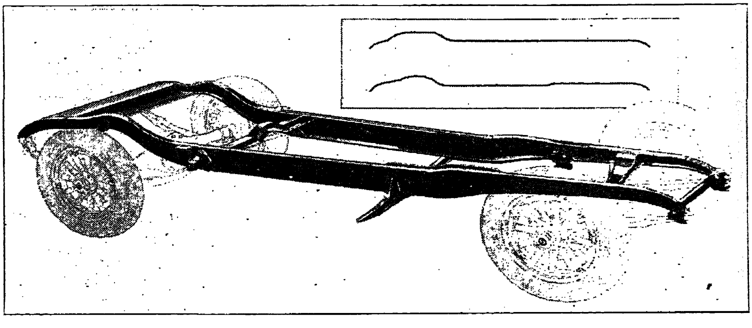


Fig. 2. Studebaker "Eight" Car Frame

Pressed=Steel Frames. The pressed-steel type of frame is very popular with designers and is largely used on commercial cars up to and including 5-ton capacity. This is popular because it is the lightest in weight for equal strength of the structural iron or rolled channel and I-beam section. The cost of pressed steel is somewhat higher, because it is heat-treated material used to obtain maximum strength. The cost varies with the section, material, and the nature and extent of bending. The finished frames are easy to handle, and the assembling cost is small. The channel shape is easy to brace and repair. These and other advantages have brought about its use.

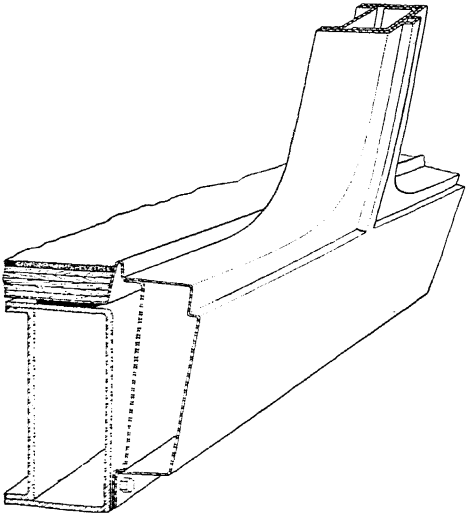


Fig. 3. Box-Section Automobile-Frame Side Member with Box-Section Body-Sill Construction Bolted to Its Side

The cheapest construction is the straight side rail, and, when conditions permit, it is usually tapered at front and the rear, and the forward end is sometimes shaped to receive the spring hangers. When the side members are inswept to permit a short turning radius, it is necessary to make the flanges of the side rail of considerable width at this point, tapering gradually to the rear, to provide the proper strength at the point of offset.

Sub-Frames. The modern tendency is to eliminate the subframe—a step due to the flexible mounting of the power plant and unit construction—because it simplifies the frame. It has also been made easier by the tapered frame, which is narrowest at the front where the units are attached.

Frame Cross Section. Fig. 3 illustrates a cross section of a car frame of box type. A narrow channel is set within the outer end of the wider channel composing the frame side member. This makes a very rigid construction and one which resists twisting or torsion to a very marked degree. The same type of construction is also used for the body sills which are bolted on to the side of the frame member. It is claimed that the rigidity of frames is increased many times over by this construction. In some of the older automobiles, it was the practice to allow the frame to weave with the uneven surfaces of the road encountered. This resulted in body squeaks and rattles, many of which are eliminated by strengthening up the frame and depending upon the springing of the car to accommodate itself to the uneven road conditions. The cross section of a side member as it has been cut in two is shown in Fig. 4. The metal is 7 inches in height and

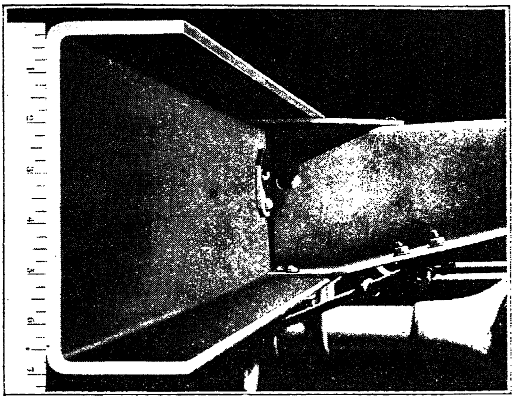


Fig. 4. Cross Section of Car Frame Showing Cross-Member Riveted Thereto
Rule on side of frame illustrates height and thickness of metal.

approximately $\frac{1}{4}$ inch in thickness. The cross-members are attached to this frame by means of rivets and gussets.

Banjo Frame. The Graham banjo type of frame is shown in Fig. 5. Each side member has been enlarged at the rear and instead of having just a simple kick-over there is a section of the frame passing beneath as well as above the rear-axle housing, which is assembled within the car frame by removing one of the backing plates which support the brake. This frame has an X section at the central portion and the forward section is what is known as a K-type section.

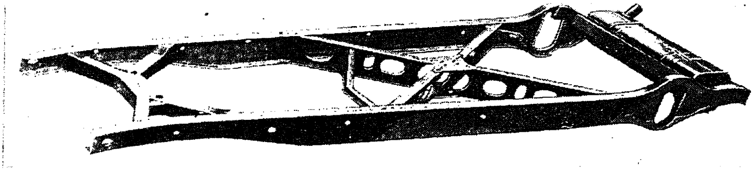


Fig. 5. Banjo-Type Car Frame Having X Section at Center and K Section at Front

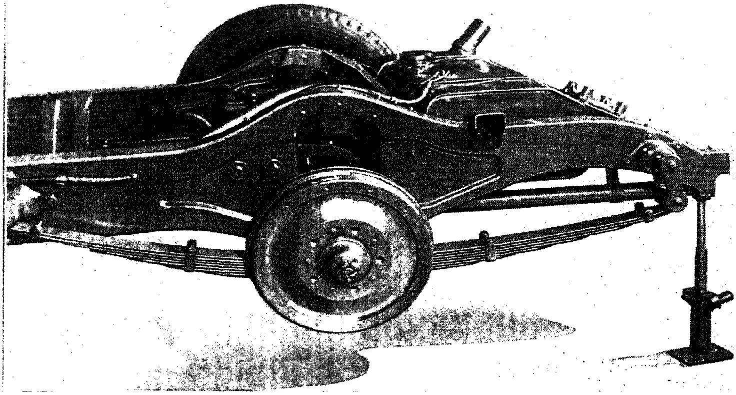


Fig. 6. Graham Banjo Frame

The type of side member used on the Graham car frame is shown in Fig. 6. The frame side member is made wide and a section of it is punched out to admit the rear-axle housing through the hole thus provided. Spring action is cared for by the depth of the opening punched through the side member. This makes a very rigid member and allows a narrower section over the top of the rear axle housing, inasmuch as a like section under the rear-axle housing serves to tie together and support the frame side member, not all support being provided through a wider member over the top of the frame, as in the conventional rear kick-up.

X-Type Passenger Car Frame. A conventional type of construction for X-type passenger-car frame is shown in the Nash, Fig. 7. In some instances the cross or X in the center of the frame is brought only to the side rails. However, in case of the one illustrated, the forward end of the X-member is carried along within the side rails to which it is riveted, giving a box effect. This box effect is quite strong and increases the rigidity of the frame materially. It will also be noticed that the forward end of the X is carried into and riveted to the forward cross member, which serves to strengthen the frame materially.

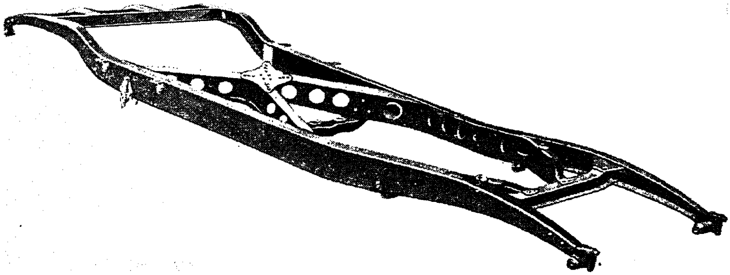


Fig. 7. Nash X-Type Passenger-Car Frame

Frames constructed after the fashion of the X-type frame are generally conceded to be much stronger and will resist deflections to a much greater degree than in the case of the older and more conventional type of frame which used only cross members for tying the job together. Engineers claim that the X-type frame is definitely eight to ten times as strong in that respect as are the older type frames. They also claim that the addition of the box section on the side rails will further increase the strength three or four times.

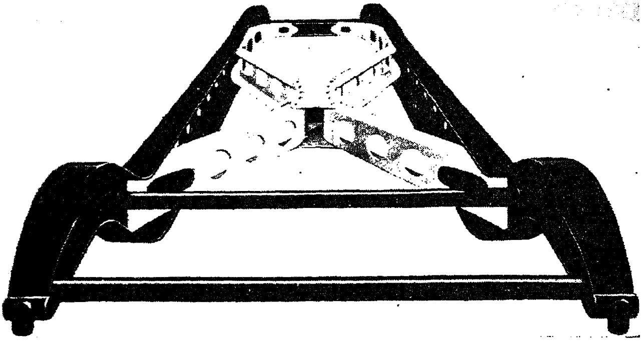


Fig. 8. A Nash Car Frame Showing Side Members in Bold Relief and Center X-A Section as Supporting Side Members

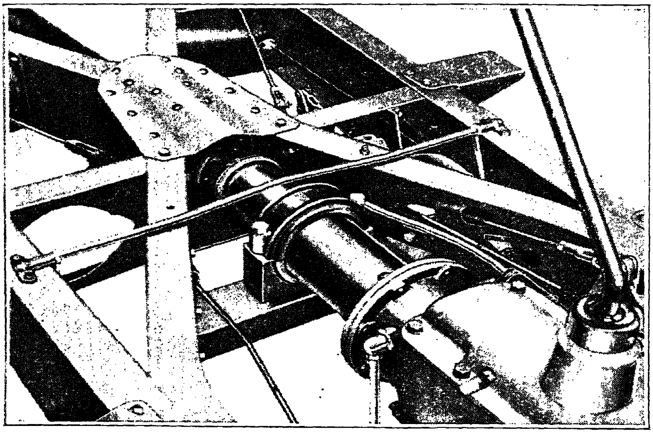


Fig. 9. X Section of Cadillac Bolted and Riveted into Car Frame Cross-Member Meeting Center of X Section
The forward propeller shaft is shown in position.

X-A Frame. The X-A type of frame of the Nash car is shown in Fig. 8. It will be noted that the frame side members have been made quite heavy and their rigidity assured by the two centrally disposed members which provide a box-type section at the forward end where they contact the side members. The tendency of the frame to twist under load is further offset by the X and A sections. In order to lighten the parts, they have been passed under the press and certain sections stamped out.

Cadillac Frame. The very strong Cadillac frame is illustrated in Fig. 9. A centrally disposed cross-member contacts the central portion of the X member, and all parts are bolted and riveted together in a secure fashion. When this type of construction is utilized, it is necessary to design very carefully in order to secure proper openings for brake controls and similar units which pass through the sections of the car frame. The use of the box-type sections makes for a very rigid frame. The rear engine support is just to the rear of the transmission housing. The tubular extension, which is bolted to the rear of the transmission housing, is supported on a rigid cross member and serves to carry the forward propeller shaft. Farther back is the forward universal joint. This construction, which provides for a divided propeller shaft, makes for shorter units which have a less tendency to whip and set up disturbing vibrations.

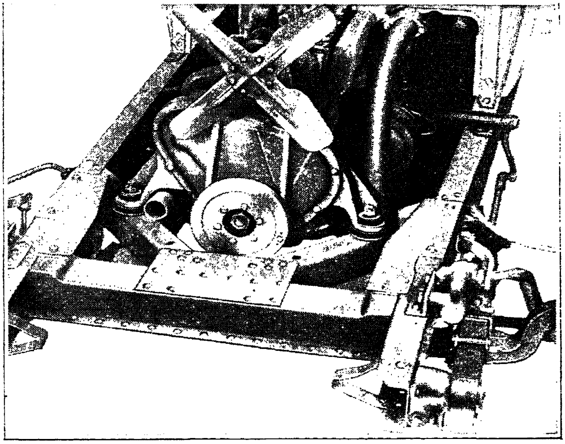


Fig. 10. K Section of Graham Car Frame with Engine Mounted in Position

Graham Engine Mounting. The K section of the Graham "Six" and "Eight" automobiles is shown in Fig. 10. The legs of the

K serve as mounting points for the forward end of the engine, these mountings being provided with rubber to prevent undue vibration entering the car frame and being transmitted thereby to the car body and the passengers. This type of construction, when assembled as illustrated, makes a very strong and rigid front end for the car frame.

Dodge Bridge-Type Frame. The Dodge bridge-type frame illustrated in Fig. 11 is similar to the other frames discussed, inasmuch as members which are bridged at the center and surround the forward end of the propeller shaft are carried on forward in box-type fashion to the forward cross-member to which they are joined. Here again we see that the members have been lightened by stamping out certain sections.

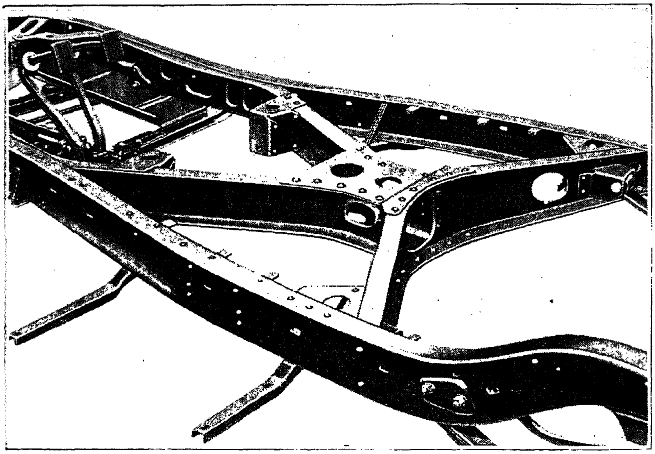


Fig. 11. Double-Drop Bridge-Type Frame Used on Dodge "Six"

K-Y Chevrolet and Pontiac Frame. The central portion of the K-Y Pontiac frame is illustrated in Fig. 12. Here it will be noted that a centrally disposed cross-member is further strengthened by having a K section to its rear and a Y section to its front. As in all cases, the central portion of these members are boxed together to allow room for the propeller shaft to pass.

Knee=Action Frame. In order to accommodate the strains induced by knee-action wheels, the design of car frames has had to be changed considerably. This is evident in the K-Y section of the Pontiac and Chevrolet frames as well as in the Buick frame, Fig. 13. Very heavy members are utilized, an X section being centrally disposed and a box-frame section running along the sides forwardly joins with the wide heavy cross-member at the forward end of the car frame. This forward member is quite wide and has riveted to it other sections, the one underneath being used to support the inner ends of the wishbone arms and the ones at the outer end being, of course, the forward end of the X-A section and the car frame, which has been spread out quite wide to permit of the newer type of wheel suspension. In this type of mounting, the axle unit has been done away with completely and all suspension units are mounted immediately onto the car frame. Underneath the wider section at the forward end are mounted the coil springs. This widened section at the forward end has the effect of adding greatly to the strength and the rounded portions provide a pivot point for the wheel, so that while the frame is wider than with conventional front-axle construction, at the same time, the amount the wheels may be turned is as great.

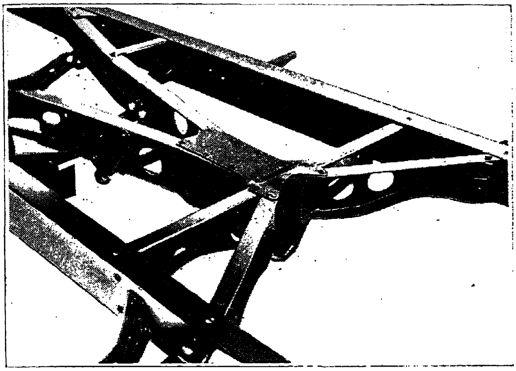


Fig. 12. Pontiac and Chevrolet K-Y Type Frame

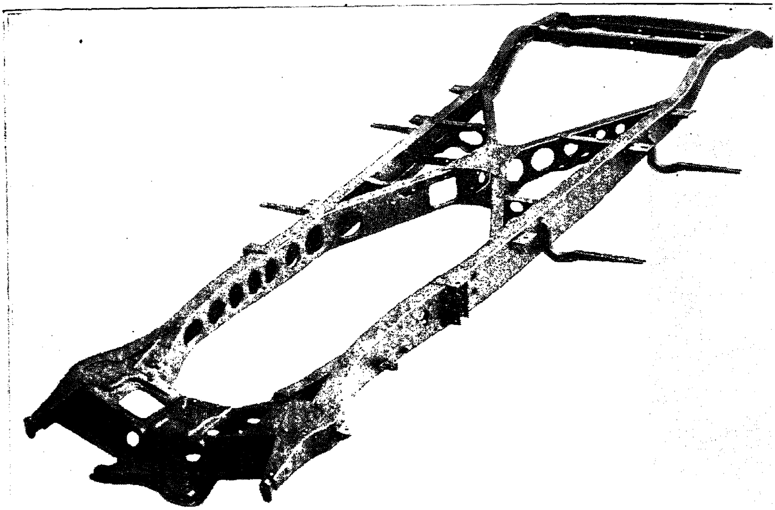


Fig. 13. Buick Frame for Independent Wheel Suspension
Note the heavy cross-member at the front end which supports the knee action wheel suspension.

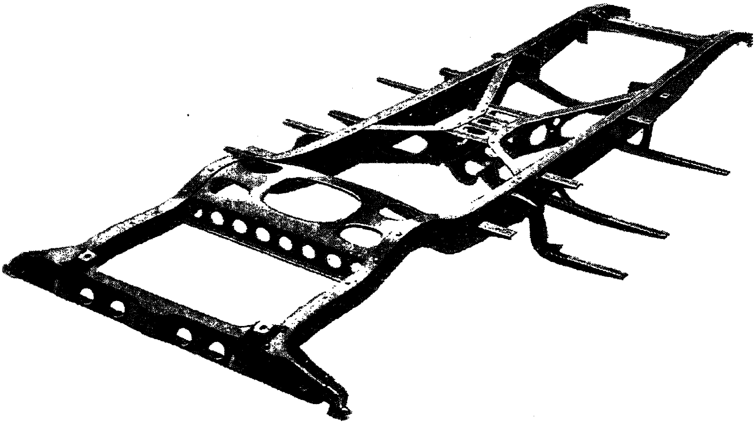


Fig. 14. Box Girder Frame Construction Hudson-Essex Cars
Note the rear cross-member which permits mounting rear springs in splayed form.

Running-Board Brackets. Running-board brackets are a definite part of the car frame, as will have been noted in a number of the illustrations, particularly in the Buick and in the Dodge, and also in the Hudson-Essex frame, Fig. 14. Formerly running-board brackets were almost universally of the same general type of those illustrated in connection with the Buick frame, Fig. 13, but later developments include many brackets similar to those illustrated for the Hudson-Essex in Fig. 14. In some cases, running-board brackets are merely cross-members thrown from side to side under the car and bolted up to the lower flanges of the frame side members.

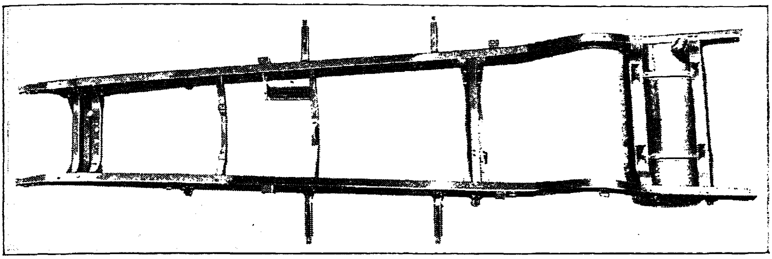


Fig. 15. Chevrolet Truck Frame

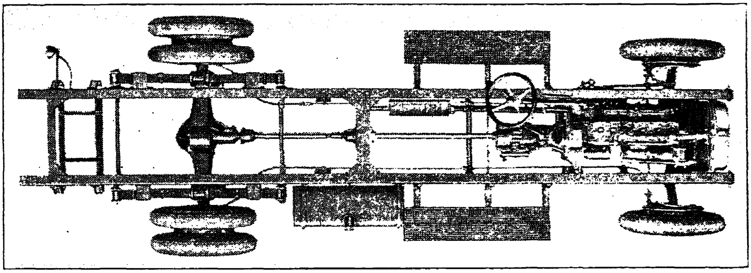


Fig. 16. Plan View of the Stewart Chassis

Frames for Commercial Cars. Frames for commercial cars continue to carry many of the characteristics of the older car frames. One of the Chevrolet truck frames is shown in Fig. 15. Naturally the heavier the load being carried by the truck, the heavier the truck frame needs to be. Many of the characteristics of construction utilized in producing good passenger-car frames are utilized in the production of heavy-duty bus and truck frames. Commercial cars carry such long frames that it is necessary to give special thought to the propeller shaft arrangement. Fig. 16 illustrates a Stewart two-ton truck chassis. A cross-member near the center of the frame carries a special floating bearing, which handles the rear end of the forward propeller shaft. One universal joint is used at the transmission and another on the rear end of the front propeller shaft. A third universal joint is used at the forward end of the rear-axle pinion shaft.

Transmissions in use in the commercial vehicles cover a wide range of shifts and speeds. In the light commercial vehicles, the three-speed transmission is popular. When the trucks approach the two- and three-ton limit, the four-speed forward transmission is in favor. In the case of extremely heavy-duty trucks, the transmission may employ as many as eight and ten speeds.

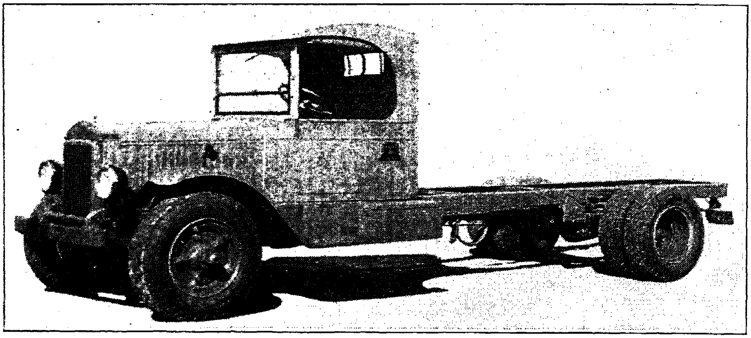


Fig. 17. Mack Truck Chassis
The rear axle carries most of the weight of the pay load and body.

The design of a chassis as used on the Mack truck is shown in Fig. 17. The rear axle is mounted about midway between the rear of the truck frame and the rear of the driver's cab. Dual tires are used to give load-carrying capacity.

FRAME TROUBLES AND REPAIRS

The more usual troubles which the repair man will encounter are sagging in the middle; fracture in the middle at some heavily loaded point or at some unusually large hole or series of holes; twisting or other distortion due to accidents; bending or fracture of a sub-frame or cross-member; bending or fracture at a point where the frame is turned sharply inward, outward, upward, or downward.

Repairing a Wrecked Car Frame. A number of devices are on the market which are quite effective when used for straightening wrecked or damaged car frames. These are designed to do the work illustrated in Fig. 18, where it will be noted that a jack, chain, and the old frame member are being used to pull the bent section of a car frame back into alignment. While the commercial equipment may be a bit more handy to use and possibly more efficient, many garage men are called on to make repairs which require them to exert quite a bit of ingenuity in some cases of car frame straightening. It is better to use a pulling effort rather than a sledge hammer. A set-up such as that illustrated in Fig. 18 will allow the workman to pull out the larger kinks and bring the frame into an approximately straight condition. While one mechanic is using the jack to exert the pressure, the other uses the blow pipe or welding torch to heat the frame at those points where the straightening should be done. When the frame is back to approximately normal condition, the hammer and dolly block may be used to smooth out the small kinks and bends. Heat should be applied judiciously when doing this work. The frame should not be brought up to a melting temperature.

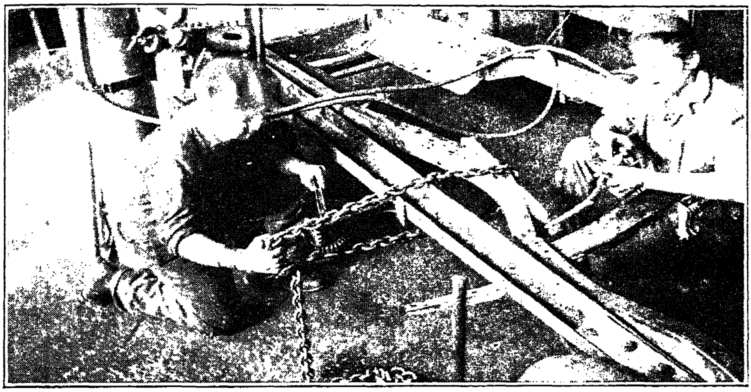


Fig. 18. A Simple Set-Up for Straightening a Car Frame

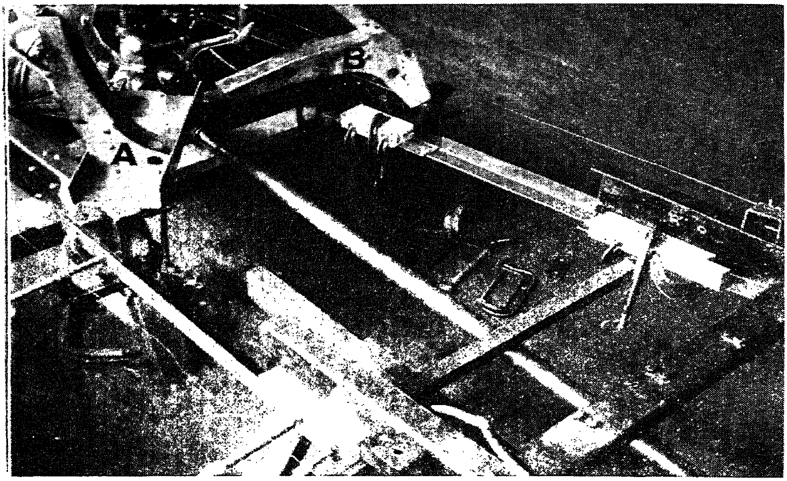


Fig. 19. Lengthening a Car Frame by Cutting It in the Center and Adding Sections

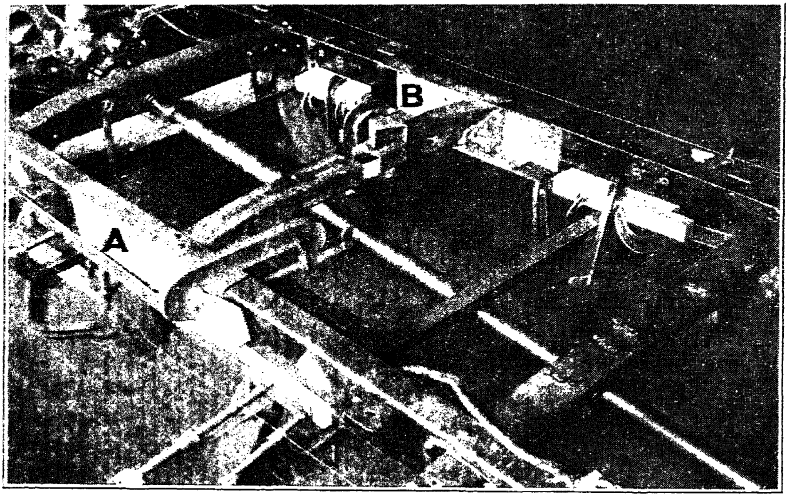


Fig. 20. The New Section Set-Up in the Side Members, Ready for Welding

Stretching Out a Car Frame. Quite frequently a job comes into the repair shop where it is required to stretch out the car frame in order to accommodate it for a new use, requiring a longer body. This is a piece of work which may readily be done in any shop having a welding torch. The frame is cut in the center and moved apart the distance it is required to lengthen the frame, as illustrated in Fig. 19. It is quite possible that another car frame will be found which will be quite similar to the one which is being lengthened. Cut sections from this old car frame, such as those shown at *A* and *B* in Fig. 19, so that they will just fit into position as illustrated in the set-up shown in Fig. 20. By making use of an old frame in this manner, the new sections contain the same type of material and fit the forward and rear portions of the frame being lengthened so that a very creditable aligning job is secured.

When welding the parts together, a better job will be secured because of the fact that the two pieces are of the same chemical analysis. When making a weld on a job such as this, be very careful to get a good clean weld, since the frame must carry the entire weight of the body and load in addition to its own weight and that of the chassis units above the springs.

Sagging. A frame sags in the middle for one of two reasons, either the original frame was not strong enough to sustain the load or the frame was strong enough normally, but an abnormal load was carried, which broke it down. Sometimes a frame which was large enough originally and which has not been overloaded will fail through crystallization or, in more common terms, fatigue of the steel. This occurs so seldom, and then only on very old frames, that it cannot be classed as a "usual" trouble; moreover, it cannot be fixed

When a frame has to be lengthened, it is also necessary to lengthen the propeller or drive shaft. There is always a certain amount of whip to a propeller shaft and of course there will be more whip to a long shaft than to a short one, and some arrangement should be made for a support bearing for the shaft at a point about midway between the end universal joints.

If there is a frame cross-member near the middle of the shaft, it may be used as a point of attachment for the bearing. It will also be necessary to install another universal joint to allow the installation of this bearing and to take care of the drive angle of the shaft.

When a frame sags in the middle, the amount of the sag determines the method of repair. For a moderate sag, say ¼ to ½ inch, a good plan is to add truss rods, one on either side. These should be stout bars, well anchored near the ends of the frame and at points where the frame has not been weakened by excessive drilling. They should be given a flattened U-shape, with two (or more) uprights down from the frame between them. The material for them should be stiff enough and strong enough to withstand bending and should be firmly fastened to the under side of the frame. The truss rods should be made in two parts with a turnbuckle to unite them, the ends being threaded right and left to receive the turnbuckle. When truss rods are put on a sagged frame, it should be turned over and loaded on the under side; then the turnbuckles should be pulled up so as to force the middle or sagged part upward a fraction of an inch, say ⅛ to ¼ inch, and then the frame turned back, the other parts added, and the whole returned to use. A job of this kind which takes out the sag so that it does not recur is a job to be proud of.

Fracture. Many frames break because too much metal was drilled out at one place. Fig. 21, shows a case of this kind. The two holes were drilled, one above the other, for the attachment of some part, and were made too large. They were so large that at this particular point there was not enough metal left to carry the load, and the frame broke, as indicated, between the two holes and also above and below. A break of this kind can be repaired in two good ways. The first and simplest, as well as the least expensive, is to take a piece of frame 10 to 12 inches long, of sufficiently small

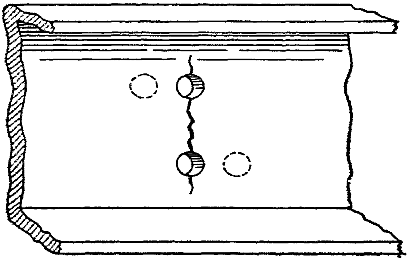


Fig. 21. Reboring Cracked Steel Channel

section to fit tightly inside this one. Drive it into the inside of the main frame at the break, rivet it in place firmly throughout its length, and then drill the desired holes through both thicknesses of metal.

This is not as good as welding. A break of this kind can be taken to a good autogenous welder who will widen out and clean the crack, fill it full of new metal, fuse that into intimate contact with the surrounding metal, and do so neat and clean a piece of work that one would never know it had been broken. When a welding job is done on a break like this, and no metal added besides that needed to fill the crack, subsequent drilling should be at an angle, to avoid a repetition of the overloading condition. In this figure, the dotted lines suggest the drilling. By staggering the holes in this way, there is a greater amount of metal to resist breakage than would be the case with one hole above the other—a method which might preferably have been used in the first place.

Riveting Frames. *Tightening Rivets.* Rivets securing the corners of a frame or holding cross-members, gussets, and plates often work loose, particularly with the flexible type of frame previously alluded to. The location of the rivet and the accessibility of the part will determine how best to proceed with the work. The chief trouble experienced is that of placing a sufficiently solid article against the rivet while the other end is being hammered. As a rule, old axes, sledges, and hammers will serve under ordinary conditions, but these cannot always be used in a channel frame. One method is to employ an old anvil which is turned upside down and so placed in the frame that the flat end of the anvil is placed against the head of the rivet, while a rivet set is employed to set the rivet up snug. The horn of the anvil is allowed to rest on the other side of the frame. This method can be used for cutting off rivets as well as for tightening old ones. The anvil should be of sufficient length to rest on the frame as above described.

When an anvil is not available, the following method may be used with success: Take a $\frac{1}{2}$-inch bolt and cut it off so that it will just go in the frame between the rivets. Slightly countersink the head of the bolt with a cold chisel. Put on the nut and slip in between the rivets and run the nut down until it expands tight in the frame. The depression in the head of the bolt, and the nut fitting around the opposite rivet head will keep it firmly in place while riveting. It is not always practical to attempt to tighten a rivet. The better method is to remove it, drill a larger hole and use a larger size rivet. Rivets are usually made of Norway iron. Heat to a red heat before using.

Riveting Methods. There are two methods of riveting, the driving in and the backing in. The latter method is shown in Fig. 22, and the two plates to be riveted are drilled in the usual manner, as shown at *A*, with the rivets a trifle smaller than the hole, placed as shown at *B*. With hot riveting, the hole should be about $\frac{1}{16}$ inch larger than the rivet, but with cold rivets, the opening should be such that the rivets will slide in. Instead of backing up the head of the rivet, a dolly is applied to the small end, as indicated at *C*, and the driving is done on the head of the rivet by a set *D* and a hammer. The energy of the hammer is applied through the set to the rivet, which is upset or enlarged, as it is unable to move because of the mass of metal in the dolly. The metal of the rivets expands sidewise at *A* and *B*, completely filling the space. A feature of this method is that a part of the hammer blow is expended in forcing the plate *N* into contact with the plate *O*. The metal at *B* is prevented from moving sidewise by a head formed at the dolly end of the rivet, and additional blows of the hammer tend to bring the plates closer and to hold them. The backing-in method is practical in making the various styles of rivet heads, particularly in making the thin, almost flush, head, and an advantage is that there are no reactionary stresses upon the thin head as would exist with the driven-in rivet.

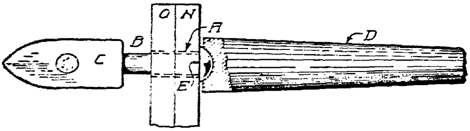


Fig. 22. Method of Riveting Frame

As there is more demanded of the rivet replacing the old member, it is important that the work be carefully performed. This applies to the holes in the plate. All sharp corners should be removed, as they afford an opportunity for the rivet to shear off by external stress or to fly off under internal strain. A reamer, drill, or countersink can be used in removing sharp corners. The face left need not be more than $\frac{1}{64}$ or $\frac{1}{32}$ inch wide, in order to greatly strengthen the rivet at its weakest point, or where the head joins the body. By slightly chamfering the corner of the plate, the rivet is given a corresponding fillet, which not only increases its holding power but serves to draw the plates together.

Frame Bracing Methods. There are several methods whereby a frame that has been injured through collision or has sagged because of too light construction can be repaired.

Fig. 23 shows a method of trussing a frame that was fractured by the stresses of the motor starter. Even after the fracture had been repaired, the driving gear of the starter would not mesh properly with the ring gear on the flywheel of the engine. As the movement was up and down on the frame, a truss was found necessary; while it was a simple matter to attach one end of the truss on the left-hand side of the chassis, the right-hand side was more difficult because of the proximity of the ball arm of the steering-gear lever. The problem was solved by forming a loop at one end of the truss of sufficient width and length to permit travel of the ball arm. By utilizing a turnbuckle the desired tension was obtained.

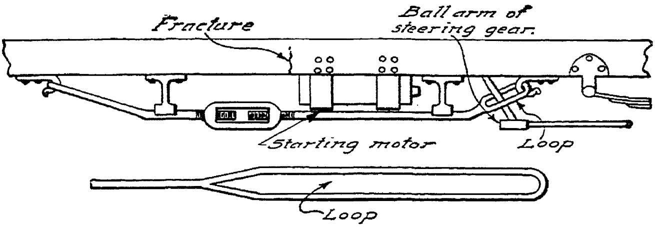


Fig. 23. Bracing Fractured Frame with Bar and Turnbuckle

Frame Alignment. It is often found that the wheels of a car do not run in track with each other. This trouble can be readily seen if a person will stand behind or drive behind a car that has this trouble. It will be noticed that the rear wheels do not run in the same track as the front wheels, while they seem to carry the rear part of the car to the side of the road causing the driver to turn the front wheels to keep the car moving ahead. This condition can be caused by two things: The axle may have shifted on the springs or the frame may be out of alignment. To check the position of the axle, measure the distance between some point on the frame, such as a stationary spring bolt and the center of the axle. If the axle is in the correct position, the distance measured will be the same on both sides of the car within one-eighth of an inch. The distance should be the same between the front and rear axles on both sides of the car when measured between the centers of the axles. If the measurements do not check the same on both sides of the car within the allowance measured, the frame should be carefully inspected for bends. Sometimes, in an accident, one side of the frame will suffer all the damage and will be driven back out-of-alignment with the other side. The first thing to do when putting a frame in such condition into alignment is to divide the frame down the center into two parts with a line, Fig. 24. The long diagonals, marked *A*, will be the same length if the frame is in correct alignment. The short diagonals, marked *B*, as measured between the cross-members of the frame, will also be of the same length. It will be noticed that in each case the diagonals cross on the center line of the frame. The side members of the frame may be bent. This condition can be checked with the aid of a straight edge, Fig. 24.

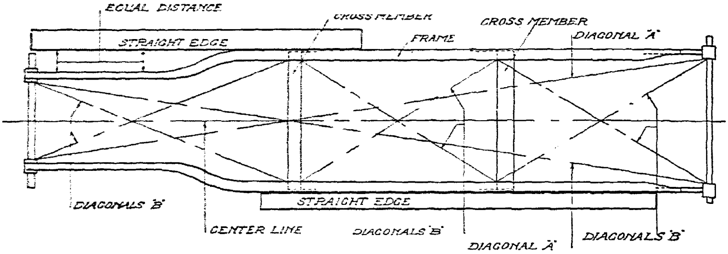


Fig. 24. Frame Alignment

Worn Spring Hangers. Through neglect, the spring hangers and spring horns may become badly worn where the spring bolt passes through them. Cut them free from the frame, fill the holes by welding and redrill the bolt holes. The parts should then be riveted back on the frame.

Worn Rivets and Rivet Holes. When rivets and rivet holes are worn, and it is not possible to fit new rivets, repair can be made as follows: Cut out the old rivets, drill the holes to a bolt size that is a little larger than the rivet so that a bolt will be a light driving fit in the hole. The nuts should be put on the bolts with a lock washer under them and pulled up tight and then the bolt ends riveted

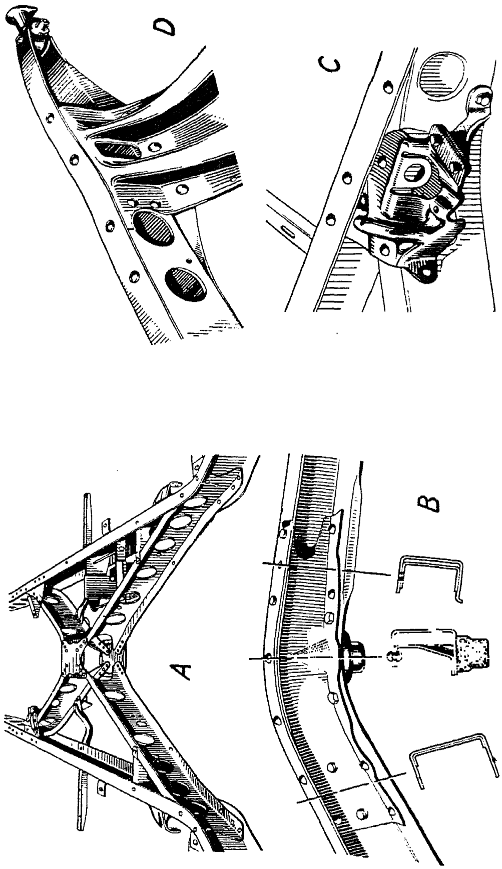


Fig. 25. Chevrolet Standard (1935 Model) Chassis Frame

over. Special care should be taken to see that the bolts are a good fit in the hole.

Car Frame Improvement. The frame for the Chevrolet standard model appears in Fig. 25 and that for the 1935 knee-action mounted front-wheel suspension appears in Figs. 26 and 27. The student mechanic will be interested in noting the tendency in "X" and "K-Y" frame bracing. The structure illustrated at *A*, Fig. 25 is generally accepted as being one of the strongest types of construction known. Not only does it carry weight in a fine manner but it resists torsional or twisting strains to a marked degree.

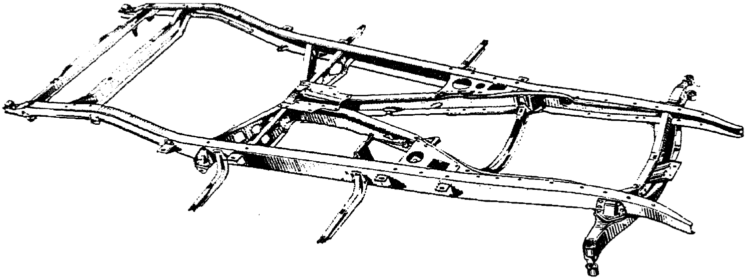


Fig. 26. Chevrolet 1935 K-Y Frame Features

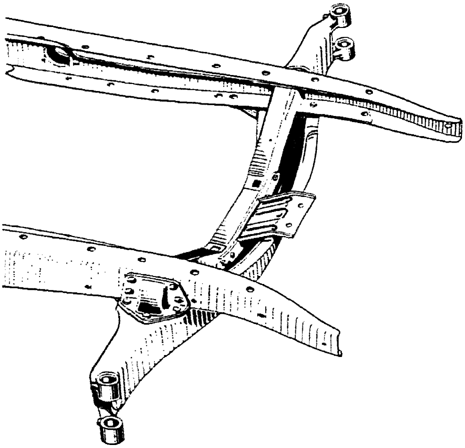
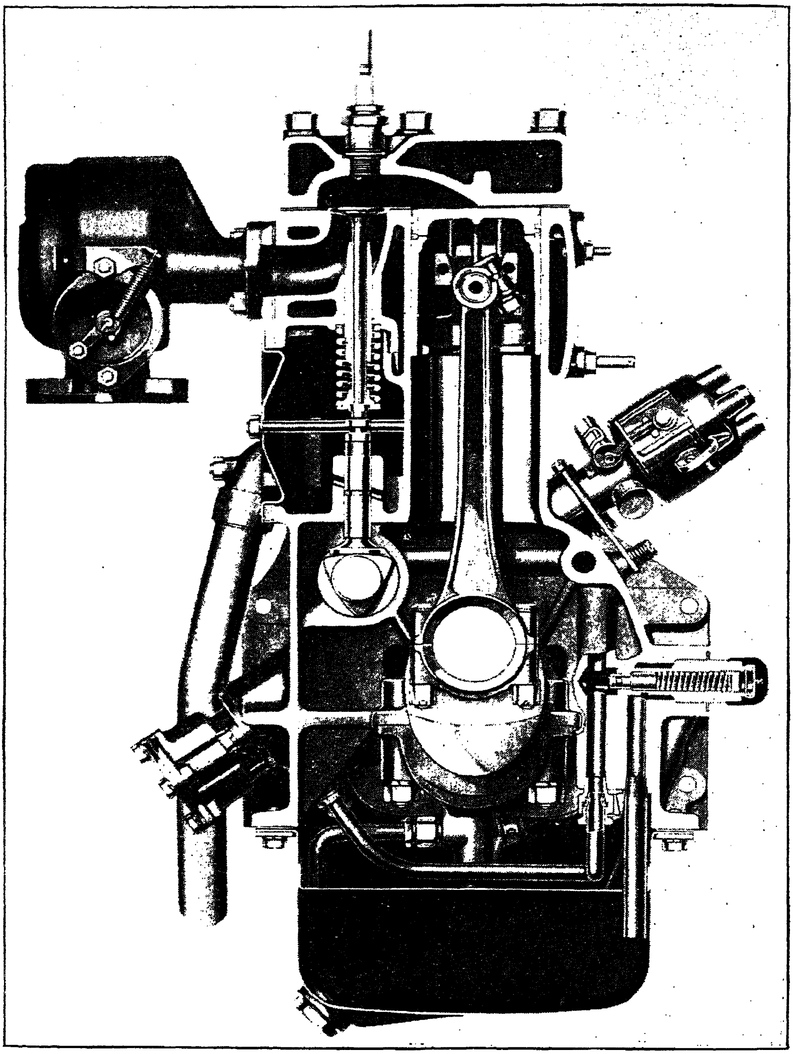


Fig. 27. Chevrolet Front Frame Member

The type of construction illustrated in the section at *B*, especially in the small figures showing the cross sections, has marked carrying and strength characteristics. Setting in the second plate within the first cross section, marked resistance to twisting is set up. The section shown at *C* illustrates the type of stamping utilized for mounting the steering gear. The section shown at *D* is the left-hand end of the forward cross-member where it is joined to the frame. Note that a box-type member is secured for the frame by the introduction of an inner member, this being the forward end of the X-member where it contacts the outer frame member and is riveted to it. The box type construction is very strong.

Owing to the fact that independent suspension for front wheels sets up entirely different strains on the car frame, a section similar to that shown in Fig. 26 is utilized by the Chevrolet Company. Fig. 27 shows in detail the method of mounting the member which takes the place of the front axle. This being in effect a frame member rather than an axle member, since no axle member is used. The difference here is in the fact that the cross-frame member shown in Fig. 27 is actually sprung weight, while in the case of all through axles, the axle beam itself is not sprung.



FRONT SECTIONAL VIEW OF ENGINE—DE SOTO

SELECTIVE TRANSMISSION

The engineering story of the transmission is a most interesting one. The early inventors used all types of gear, belt, and friction drives in an effort to discover an ideal means of transmitting the power from the flywheel of the engine to the rear axle or driving wheels of the car.

The ideal transmission is granted. It is one in which the ratio between the engine speed and the rear axle speed is infinitely variable. An early approach to this was the friction drive which consisted of a large plate attached to the propeller shaft and against which a friction wheel was forced so that the rotation of the disc caused the friction wheel to be driven and, in turn, it was used to turn a shaft, and the power was transmitted to the rear driving wheels by means of chains, belts, or otherwise. Naturally, the least movement of the friction wheel on the plate caused a change in speed or driving ratio—the nearer the center, the lower the speed of the car; and the nearer the edge, the higher the speed of the car. When the friction wheel passed the center of the driving disc, reverse drive was secured with a number of speed ratios. The Carter car was the outstanding example of the application of this principle. It passed into history a score of years ago.

The use of the helical gears, as shown in Fig. 1, is a more recent solution of the problem of a quiet transmission.

Sliding=Gear Transmission. The sliding-gear transmissions were and are popular because of their simplicity and the rugged construction which is possible. The great objection to this type of gear has been the shifting. In the early stages of the development of the sliding gear what was termed the "progressive type" was used. Where this construction was employed, it was necessary to shift from neutral into low, and from low into reverse. In other words it was necessary to go through low-forward in order to get to the reverse gear. Consequently, when passing from reverse speed, it was necessary to go into and through low before coming to neutral, from which position the shift was then made into second, and finally into high. Again, in order to get out of gear, it was necessary to pass from high gear through second-speed gear into neutral. This design met with considerable favor for a few years and a modification of it, known as the progressive-selective transmission, was used for a number of years in high-grade cars. In the progressive-selective transmission it was only necessary to go through low to reach reverse, all other gears—low, second, third, and high speed—being reached directly from neutral and being selected at will by the operator of the car.

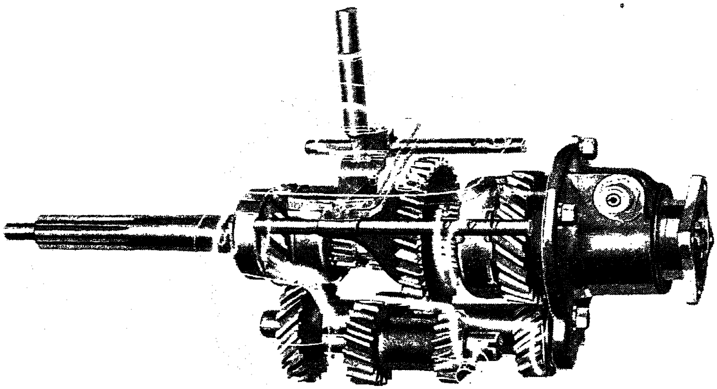


Fig. 1. Oldsmobile Synchro-Mesh Transmission with Silent Helical Gears for All Speeds

As a result of considerable experimentation, the three-speed sliding gear, selective type transmission, was developed and found wide favor. For many years it was built in the simplest possible form and used almost universally. This design continues to be the basis on which most transmissions are constructed. For the sake of a clear understanding of the principles of the transmission, the simplest form is described in the following paragraphs. Later pages are devoted to an exposition of the many refinements of this design.

Three-Speed Forward Selective Transmission. The three-speed forward selective transmission, Fig. 2, was considered the standard of good engineering practice, and for almost a score of years very little change was made in the underlying principles of design. In this transmission, it is possible to reach any gear or speed from neutral. One reverse and three forward speeds are a standard provision.

Modification of the Three=Speed Gear Box. Flexibility and quietness of operation together with economy of operation have

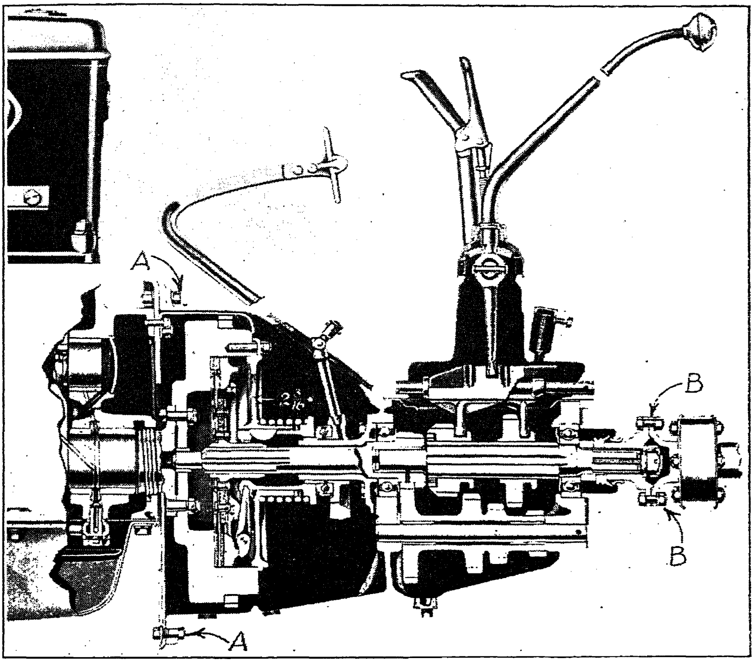


Fig. 2. The Conventional Three-Speed Selective Gear Transmission

brought great pressure to bear on the engineering fraternity so that the three-speed forward transmission has not continued to meet the demands placed on the engineering fraternity by the consuming public. There are certain underlying engineering principles, which all service men should understand. In the first place the automobile engine, being an internal combustion engine, develops but little power until it has reached a certain speed. Consequently under load, it is necessary to have a fairly high engine speed for a low car speed. On the other hand, when the car is moving on the level road, no particular load is on the engine, and since the engine is turning over at a higher r.p.m., it is developing a great deal more power, and the power developed is quite ample to propel the car in a satisfactory manner, even though the gear ratio between the engine and the rear axle should be such as to give a high car speed for a low engine speed.

For a time it seemed as though the engine speed could be increased indefinitely and an axle gear ratio could be used which would allow rapid pick-up or swift acceleration and sufficient power on the hills to obviate gear shifting except in extreme cases. This meant the use of a rear axle gear ratio of approximately five or five and one-half to one. Presently owners were complaining about a body rumble, which was induced at high engine speeds. While wonderful refinements were made in the engines, the demands of the public have resulted in the incorporation of an extra speed in the transmission by many builders of motor cars. This extra speed or gear frequently takes the form of an internal gear. However, in some outstanding instances of fine motor cars, the spur type of gear is retained and manufacturing refinements have been included.

Bus and truck demands have been met by the four-speed forward type of transmission, using the conventional spur type of gear. The noise, caused by the operation of the gear set in other than high gear is not considered objectionable, and this design is used in general on this type of vehicle.

The history of the transmission is one with actual accomplishments and ideals which have met with popular acceptance. The ideal transmission is being studied by the engineering fraternity and a great variety of transmissions have been designed, built, and used with more or less satisfaction in an experimental way. Doubtless the transmission which is infinitely variable with reference to gear ratio is a desirable unit and one that is being approached more closely from year to year.

Three=Speed Sliding=Gear Selective Transmission. Fig. 2 illustrates a conventional transmission unit of the three forward speeds and one reverse type. The duties and relation of the various parts are shown in Figs. 3 to 10. Fig. 3 illustrates the clutch shaft with the high-speed clutch gear *A*, and the ball bearing *B*. The roller bearing fits within the high-speed clutch gear *A* and carries the forward end of the sliding gear shaft *A*, Fig. 4. This bearing is shown at *B* in Fig. 4 where it is lying under that portion of the shaft which it supports. The high-speed and second-speed sliding gear is shown at *C*, while the low speed and reverse sliding gear is shown at *D*. It will be noted that the gear hubs are splined to fit the splines on the transmission shaft. The jack shaft with its four gears is shown in Fig. 5. The driven gear is *A;* the second speed gear is *B;* the low-speed gear is *C;* while the gear *D* engages with the reverse idler gear *A*, shown only in Fig. 9. This reverse idler is carried by a short idler shaft, known as the reverse idler gear shaft.

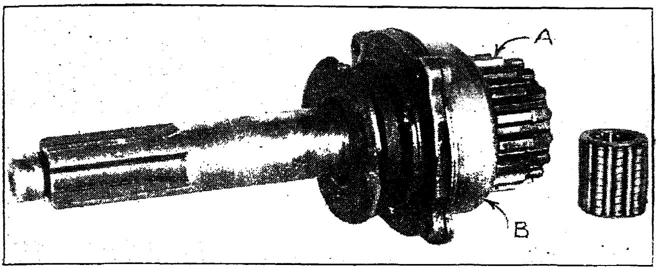


Fig. 3. Clutch Shaft with High-Speed Clutch Gear

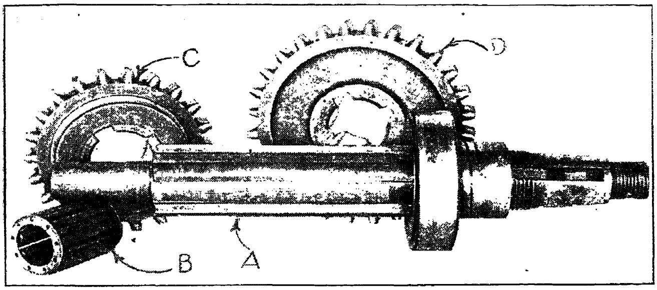


Fig. 4. Sliding Gears on Transmission Splined Shaft

Continuing the study of the transmission a bit further, the parts have been assembled in Fig. 6, which shows the line of drive through the transmission when the car is being driven in high gear. The power delivered to the clutch shaft *A* by means of the clutch is transmitted to the high-speed clutch gear *B*, and from that point directly to the high and second speed shaft gear *C;* and since this gear locks on to gear *B* and also is locked to the transmission shaft *D* by means of the splines, it will be seen that the shaft *A* and the shaft *D* must turn as one shaft.

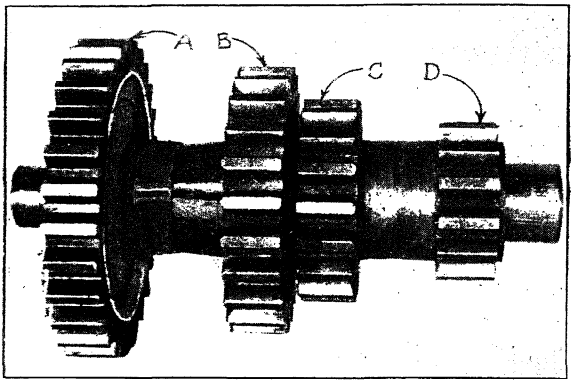


Fig. 5. Jack or Countershaft

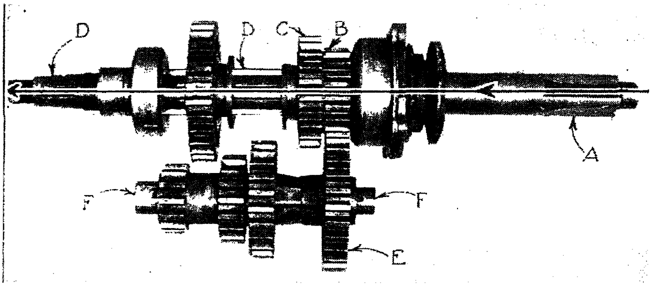


Fig. 6. Position of Gears in High or Direct Speed

Second Speed. The gear *B* is always turning when the clutch shaft *A* turns, and it is always in mesh with the constant mesh gear *E*, which in turn drives the jack shaft *F*, so that the jack shaft *F* is constantly turning when the engine is running and the clutch is in. Now if the gear *C* is shifted away from the gear *B*, Fig. 6, and over into contact with the gear *G*, Fig. 7, then it will be seen that the drive is according to the line and arrows shown in this figure—that is, it goes from the clutch shaft to the high-speed clutch gear, then to the constant speed gear, to the jack shaft, and from the jack shaft to gear *G*, and thence through gear *C* and back to the transmission shaft *D*, which is connected to the propeller shaft and rear axle.

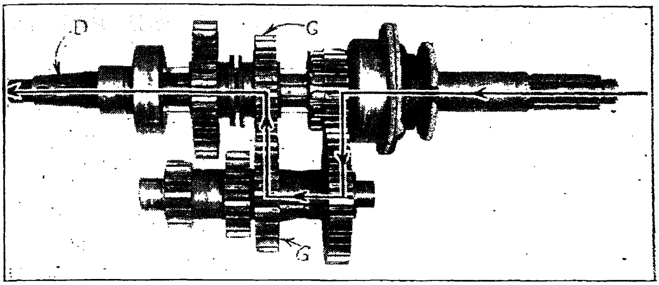


Fig. 7. Position of Gears in Second Speed Forward

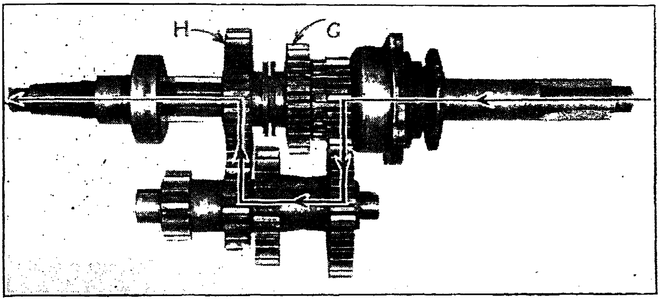


Fig. 8. Position of Gears for Low Speed

Low Speed. When the gear shift lever of the transmission is thrown into neutral, the gear *C* takes the position shown in Fig. 8, and when the gear *H* is shifted into the position it occupies in Fig. 8, we have low-speed drive, and the line of power flow is according to the arrows and line shown.

Reverse. It is only when the transmission is put in reverse that the idler reverse gear *A*, Fig. 9, is used. The gear *H* corresponds to the gear *H* in Fig. 8, and it will be noted that it has been shifted toward the ball bearing or the rear of the transmission shaft so that now the power flow is as indicated by the arrows in Fig. 9, which is just the same as for the other figures, with the exception that since the reverse idler gear is running in a reverse direction from that of the gears on the jack shaft, it will hold that when the shift gear *H* is put into mesh with the reverse idler gear, it too will have a reverse direction over that which it had when it was meshed with the low forward speed shown in Fig. 8, and the introduction of the extra gear, known as a reverse idler gear, is necessary to change the direction of speed.

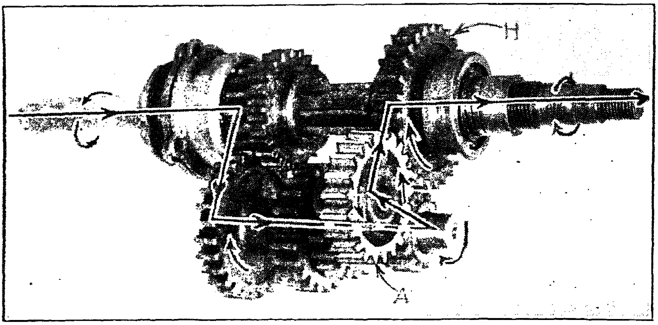


Fig. 9. Position of Gears for Reverse
The Unit has been reversed when compared to Figs. 6, 7, and 8.

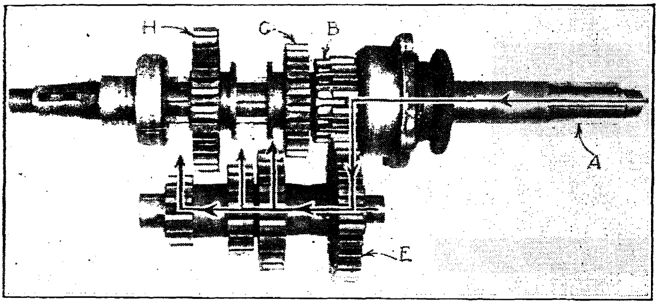


Fig. 10. Sliding Gears Are in Neutral Position

Neutral Position. Neutral position is illustrated in Fig. 10, where it will be seen that any power coming from the clutch shaft *A* goes to the high-speed clutch gear *B* and is used to drive the transmission jack shaft gear *E* and turns the jack shaft *F*. However, since high and second speed sliding gear *C* is not meshed with any gear and since the other sliding gear *H* is not meshed with either the low-speed forward gear or the reverse idler gear, the condition known

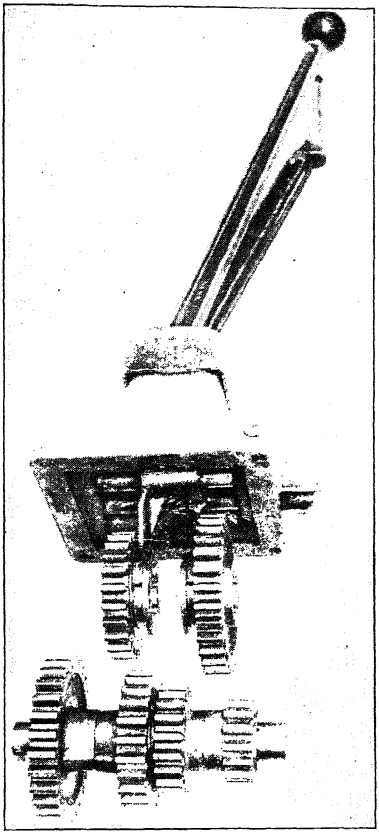


Fig. 11. Sliding Gears in Neutral Position in the Shaft Yokes; Countershaft Below

as neutral position is secured. The gear shift control and the control yokes, Fig. 11, are so designed as to hold these two shift gears in what is known as the neutral position, illustrated in both Figs. 10 and 11, when the shift lever is in center or neutral position.

OVERHAULING A TRANSMISSION

Methods of overhauling a three-speed selective type transmission are rather similar for most cars equipped with this type of transmission unit. Naturally there are minor differences which must be taken into consideration. The transmission illustrated in section in Fig. 11 is representative of good practice with reference to the three-speed forward selective type transmission. There is quite a bit of variation in the methods of mounting the transmission bell housing on the engine. In some instances the bell housing is designed to carry practically all of the weight from the upper half of the bell housing, while in other instances the flywheel housing is designed and manufactured separate from the transmission bell housing, with the result that a full ring type mounting is available.

Removing the Transmission. When removing the transmission from the car, several items must be given consideration. Where the enclosed propeller shaft drive is used, it will be found that it is necessary to move the rear axle rearward in order to get at the propeller shaft joint and open it up. Where the car drive is through the enclosed propeller shaft housing, or the torque tube type, a similar condition exists. While it is true that there are some tricks employed by some mechanics in removing transmissions from certain cars employing this type of construction, generally speaking, the best and safest method is to drop the rear axle and pull it back.

Where the construction is similar to that illustrated in Fig. 12, the propeller shaft is first dropped by removing the bolts *B*, Fig. 2, after which the transmission bolts *A*, Fig. 2, are removed from the bell housing, and then the transmission may be dropped down by first moving it backward and then lowering it to the floor. When this is done, the single plate clutch assembly remains in the flywheel in which it is mounted and the clutch shaft is pulled with the transmission. When the transmission is on the floor, it is slipped from under the car and taken to the bench where it is completely disassembled.

Disassembling a Transmission. The first step in disassembling a transmission is to remove the transmission cover, Fig. 12, with the gear shift lever. Sometimes the hand brake lever is also attached to this cover and is lifted away with the unit. This work is done before the transmission is dropped to the floor, as it keeps the handle and parts of the unit out of the way and facilitates the job. When removing the transmission cover, note carefully the relative position of the two sliding gears so that when the job is reassembled, no mistake will be made with reference to neutral.

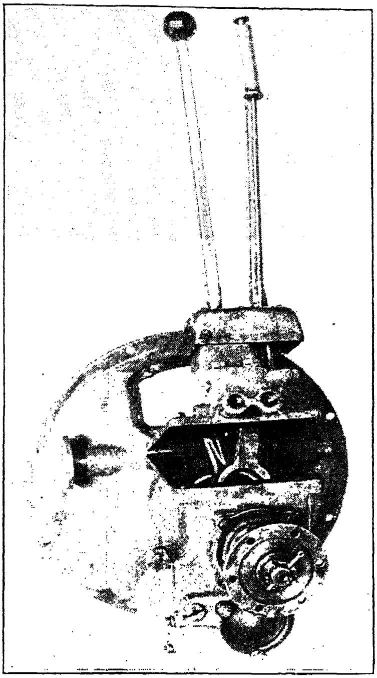


Fig. 12. Removing Transmission Cover with Gear Shift and Brake Handle

Place the transmission on the bench and proceed to pull the propeller shaft flange *A*, Fig. 13, or yoke, as the case may be. Next pull the bearing containers *B;* also pull the clutch control shaft, from points *D* and *E*, which is ordinarily found to be divided with a short length opposite the longer length on which the clutch pedal is mounted. This will allow the removing of the clutch yoke *C*. When these parts have been removed the bearing retainer which houses the forward main transmission shaft or clutch shaft bearing, which is similar to *C* in Fig. 14, may also be removed. The rear part of the transmission shaft *A*, Fig. 14, is pulled toward the rear and as it is pulled out the workman removes the sliding gears through the top of the case, as illustrated at *B*. The transmission forward end of the transmission shaft or clutch shaft with the high-speed clutch gear is pulled forward, as shown at *A* in Fig. 15.

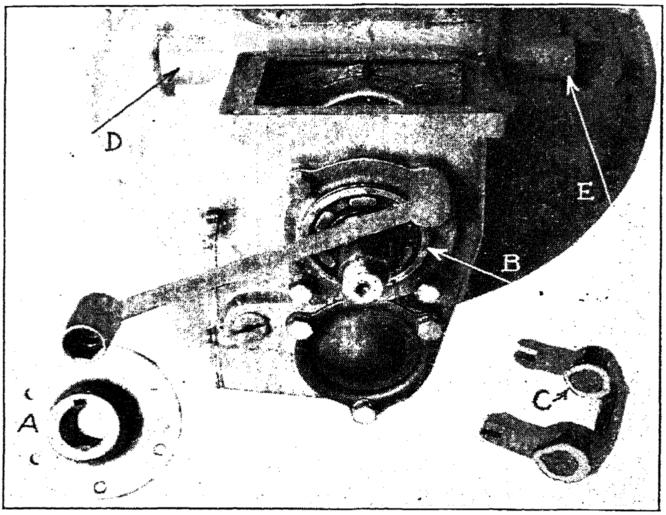


Fig. 13. Removing Universal Flange and Bearing Retaining Flange

The next step is to remove the idler shaft retaining device, which may be a pin, as shown at *A* in Fig. 16. After this pin has been removed, the reverse idler shaft may be drifted out and the idler gear pulled either from the inside or outside of the case, depending upon the construction. In the job illustrated, a special cover *B*, Fig. 15, is used. This is removed so as to permit the removal of the

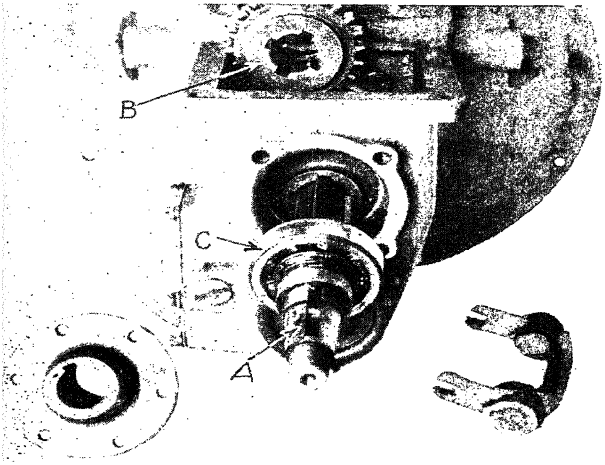


Fig. 14. Removing Splined Transmission Shaft and Sliding Gears

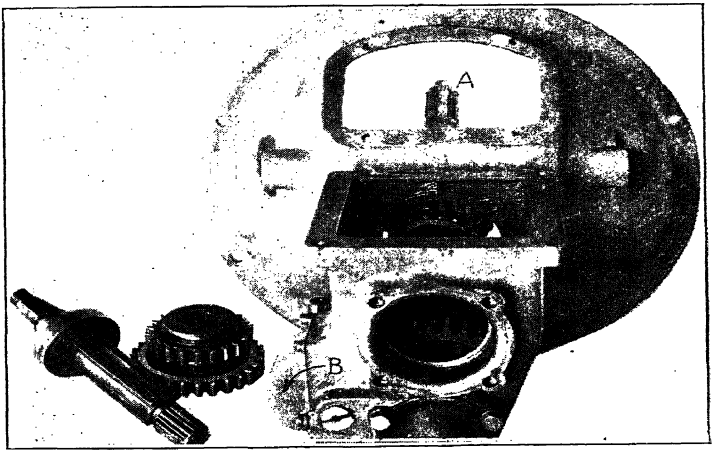


Fig. 15. Removing Clutch Shaft

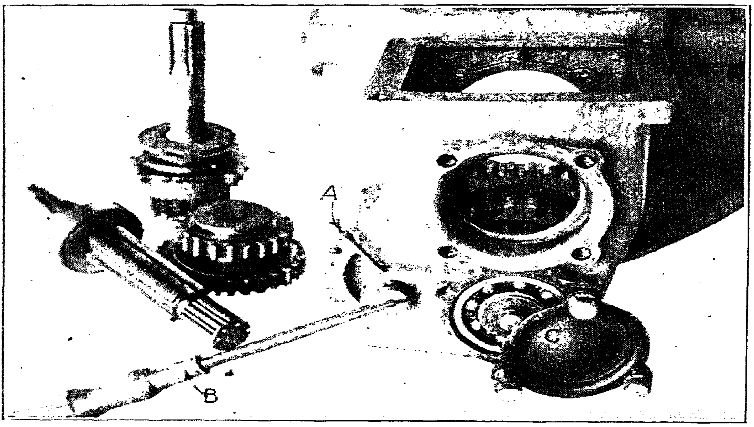


Fig. 16. Removing Countershaft Bearings and Reverse Idler Shaft and Gears

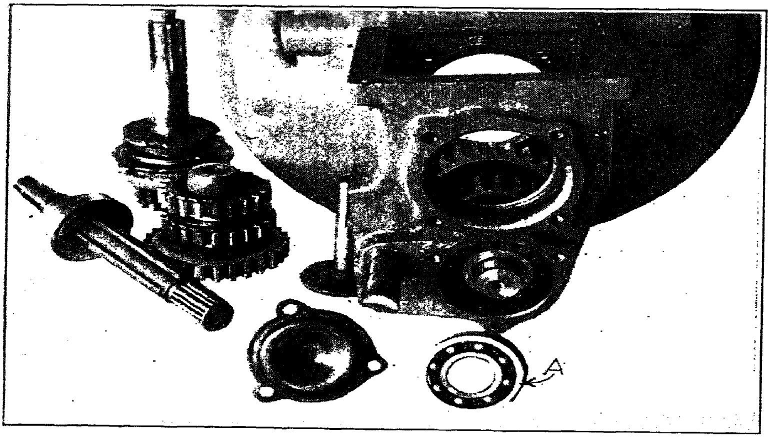


Fig. 17. Ready to Complete Disassembly by Lifting Out the Countershaft

reverse idler gear. When replacing the idler gear shaft, a screwdriver may be used, as shown at *B* in Fig. 16, to turn the shaft and cause the pin hole to line up.

As a rule, the next step is to remove the jack shaft bearing cover *C*, Fig. 16, and pull the ball bearing as shown at *A* in Fig. 17. This will allow the jack shaft to be slipped backward far enough to free the forward end of it, after which it may be lifted through the top opening of the transmission case. This completes the disassembling of the transmission and all of the parts are laid out on the bench for inspection.

Checking Worn Transmission Parts. The most usual failure conditions in transmissions of the sliding-gear type are gear wear, shaft wear, and bearing failure. These usually result only in noisy operation and comparatively seldom result in complete failure or a stalled car. In other words, actual stripping of transmission gears is very seldom encountered.

The causes of rapid wear in a transmission are failure of proper lubrication of the gear set, operating a gear set with abrasive particles in the gear grease or lubricant, careless shifting, which places a load on the gears before they are meshed for their full width.

Sometimes the transmission may fail because of careless shifting, which results in the shifting forks being sprung to such an extent that the gears will no longer mesh for their full width. When this happens, gear wear is not even and the gears eventually become tapered, Fig. 18, and the teeth wedge shaped, so that when a load is placed on the gears they tend to skid or slip apart. Wear such as this results in corresponding wear on the sliding gear shaft, and thus the sliding gear crawls so that it is practically impossible to hold the transmission in gear, say in second speed, when climbing a long hill or accelerating in traffic.

Where gears are worn in the manner of those illustrated in Fig. 18, they should be replaced with new ones. The transmission sliding-gear shaft should be checked most carefully to see whether it has become worn. When the teeth of the transmission gear are pock-marked, it indicates that the casehardening has been penetrated, and gears in this condition should be replaced.

Inspect the jack shaft and the jack shaft bearings to see whether they have become worn. Where a plain type of bushing is used bearing wear allows the gears to separate, the proper tooth clearance is no longer secured and gears operate in a very noisy fashion. Where a ball bearing is used, make a careful inspection to see whether the balls within the races are all in perfect condition. Use compressed air and gasoline to blow out the accumulated grease and dirt. The bearing should spin freely, but it should not show any appreciable amount of play. When reassembling the bearing in the transmission case, extra care should be taken to note which face of the bearing is toward the outer end of the transmission case. Ball bearings are usually made with a thrust side and are not designed to take a thrust load in both directions. Failure may result if they are installed backward.

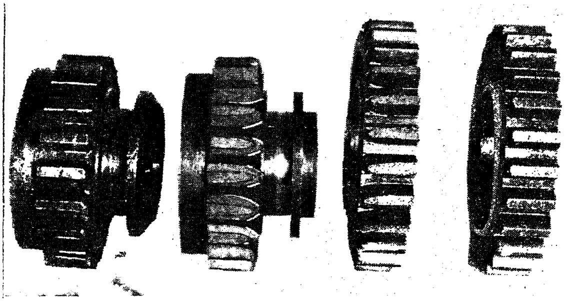


Fig. 18. Gears Worn Tapered Will Not Stay in Mesh

In some transmissions, especially on heavy duty jobs, the tapered type of roller bearings are used. These should be checked for any undue wear or flaws and when the job is to be reassembled, exact adjustment should be secured. This means that the bearings should be set up until they just drag the least bit and then backed off for two or three notches on the adjustment ring until there is a very slight amount of end play.

Inspect the grease retaining devices of the transmission. These may be cork or felt or they may be of the grease or oil type so designed as to throw off the oil or automatically return it to the transmission when it starts to follow along the bearing or shaft toward the outside of the case.

Reassembling the Transmission. When reassembling the transmission, the steps involved in the disassembling operation are reversed. Be very certain that no abrasive particles or broken bits of steel remain in the transmission case. The best way to remove them is to scrub the case inside and out with kerosene or gasoline or to make use of one of the modern type cleaning tanks, and then follow with a careful inspection, wiping away any dirt. At this point it may be stated that it is a good plan to inspect the transmission of a new car after it has had a few hundred miles of service, and if the transmission grease shows grit or bright particles of metal when rubbed between the fingers, the grease should be drained off and replaced with new lubricant. A good method of checking the transmission or differential grease is to use a magneto magnet and dip it into the grease. The grease which has adhered to the magnet is carefully washed away in a pail containing gasoline, and any particles of iron or steel which were suspended in the grease will be left clinging to the magnet. A demonstration such as this is a very simple way of selling transmission and differential lubrication.

As the transmission rebuilding proceeds, make certain that all grease retaining units are installed properly and are in good condition. Also make certain that all bearing retainers are properly locked in position and that all parts requiring wire, cotter keys, or lock washers, are properly secured. Finally, when the transmission is ready for reassembling in the car—that is, all work done except installing the gear-case cover and shifting forks—slip a piece of cardboard over the transmission cover and drop in several of the transmission cover cap screws to hold it in position. This prevents any dirt or foreign objects finding their way into the transmission to cause trouble at a later date.

Installing the Transmission in the Car. Slip the transmission housing in position and then lift upward, slipping it forward over the flywheel and at the same time engaging the clutch shaft splines with the clutch hub. In case the clutch also has been overhauled, the clutch hub splines should be aligned in position by means of an old clutch shaft so that when the transmission assembly is to be mounted no difficulty will be experienced in having these parts engage. The forward end of the clutch shaft is supported in a pilot bearing mounted within the flywheel flange and unless the clutch parts within the flywheel are properly aligned before hand, it will be found practically impossible to complete the assembly.

When the bell housing starts to come to position, install the bell housing cap screws *A*, Fig. 2, and draw them up gradually over all points so as to bring the parts together evenly. If any marked resistance is encountered, do not try to force the parts, but inspect to see where the trouble may be. Sometimes the pilot bearing may be a rather snug fit or some of the clutch parts may be causing the difficulty. If the assembly is practically complete, the clutch pedal may be thrown out and other parts worked about, in an effort to secure proper alignment which will permit complete assembly.

When the transmission is bolted snug, the other parts which have been disassembled in order to get at the transmission, such as the axle, universal joints, and the propeller shaft housing, should be reassembled and all parts locked securely. Finally, remove the cardboard cover and fill the transmission with grease to the proper level, which is usually marked by the height on the filler plug. The transmission cover with its parts should be installed, making certain that a good gasket is in the cover and that the shifter forks properly engage with the shifter fork flanges on the two sliding gears as shown in Fig. 11. Lock the transmission cover in position with cap screws and lock washers, after which the floor boards and other incidental parts may be installed and the job cleaned up ready for delivery to the customer.

DODGE TRANSMISSION

The Dodge transmission is of the selective type, three speeds forward and one reversed. The gears are helical and the main shaft has helical splines, Fig. 19, on which is mounted the low speed gear. The second speed gear, which is mounted on the main shaft, is in constant mesh with the second speed countershaft gear and, because of the helical teeth used, the transmission is quiet in operation at all speeds. Low and reverse gears are of the sliding gear type.

For easy, quiet gear shifting, a synchronizer is used in which is incorporated a sliding clutch sleeve. The high speed and second sliding gear clutch is simply a device to synchronize the speed of rotation of the clutch sleeve with the speed of the high and second speed gears. The device also helps in lining up the gear teeth before the final engagement is completed.

On the rear end of the high speed gear, and on the forward end of the second speed gear, cones are formed. Inside the sliding clutch gear similar cones are constructed so that when moving into second speed from the neutral position, these cones contact each other and cause the hub of the sliding clutch gear to rotate at the same speed as the second speed gear. As the second speed gear and the sliding clutch gear are rotating at the same speed, it allows the teeth in the sleeve to be engaged. The sliding sleeve has internal cut gear teeth which mesh with the external cut teeth in the second speed gear. When changing from neutral to direct or high speed,

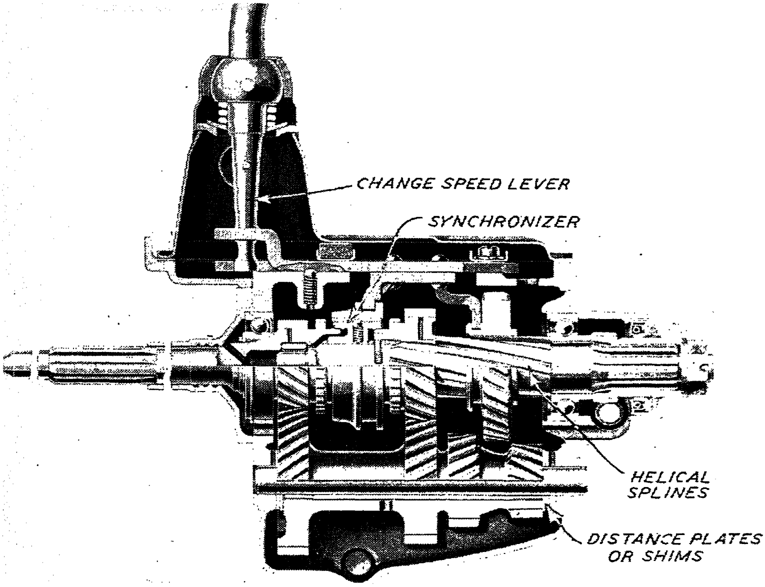


Fig. 19. Dodge Transmission
Courtesy of Chrysler Motor Corporation, Detroit, Michigan

the sliding clutch sleeve moves forward. Whenever it is necessary to service the transmission, attention must be paid to the end play of the second speed gear, main drive shaft, and countershaft gear.

A washer controls the end play of the second speed gear, and it also holds the gear in place. The permissible end play is .003 inch minimum and .008 inch maximum.

Countershaft gear assembly end play is controlled by thrust plates of different thicknesses, and the end play should not exceed .011 inch and should be not less than .002 inch.

LINCOLN-ZEPHYR TRANSMISSION

The Lincoln-Zephyr transmission is extremely quiet in operation at all speeds, owing to the use of constant mesh helical gears. The transmission has synchronized gears providing three speeds forward and one reverse.

The drive shaft is splined, and the lower and reverse speed gears slide on it, while the second speed gear which is in constant mesh with the synchronizing unit, is carried by the spline shaft. In high gear this shaft, with the clutch shaft, forms the direct or high speed drive connection from the engine by way of the clutch to the propeller shaft, and so to the rear axle.

The high speed gear and clutch shaft are integral and always in mesh with the forward gear on the countershaft assembly.

With the engine running and car still, clutch engaged, and with the gear-shift lever in neutral position, all the gears are moving excepting the gear synchronizing unit and reverse and low speed sliding gear. Until the synchronizing unit is meshed with the second or high speed gear, or until the reverse or low speed driving gear is meshed with the corresponding gear in the countershaft, there can be no power transmitted to the drive shaft.

The gear synchronizing device is equipped with friction cones on either side, and has an outer ring which is engaged by a shifter fork and controlled by the change speed lever. The outer ring is kept centrally located on the unit by spring-actuated plungers, and can slide either backwards or forwards in the synchronizing device, to engage either the high speed or second speed gears at option.

As the gear-shift lever is moved from either first to second or from second into high, or from high to second, the synchronizing unit friction cones come into contact with the mating cones on either the second or high speed gears. The contact between the mating cones causes the gears to revolve at the same speed. As the movement of the lever continues, it causes the outer ring to move farther back or forward, meshing the high or second speed gears. This action is practically completed in one continuous motion of the gear-shift lever.

THE NASH CRUISING GEAR

The following description of the construction and operation of the Cruising Gear, shown in Fig. 20, will enable one to become familiar with its operation and demonstration.

The Cruising Gear mechanism is a self-contained unit operating actually as a part of the conventional transmission. The speed reduction is accomplished by what is commonly known as a planetary gear set.

The gears consist chiefly of three elements: first, the sun gear which is anchored to the front side of the unit housing by means of a dampener containing cushion springs; second, the pinions, of which there are five in number and which revolve around the sun gear; third, the ring gear. These parts are shown in Figs. 21 and 22.

The sun gear just mentioned is hollow and through it there is a sliding shaft. This shaft is controlled by a selector lever on the dash which by shifting the sleeve selects the unit either for drive or overdrive.

It is not necessary to shift by hand into Cruising Gear; this is done automatically as will be explained. The shifting done by hand is simply to make the Cruising Gear unit operative or inoperative.

The essential elements of the planetary gearing have been named, but it has not been shown how the power gets from the engine through the gears. This is done automatically by what is called a centrifugal clutch, Fig. 21. This clutch is set, let us say, to engage at forty-five miles per hour. The sliding shaft, Fig. 22, connects with the transmission main shaft by internal and external splines. At the opposite end of the sliding shaft there are teeth which in the Cruising Gear position mesh with teeth in a plate or, as it is called, a core. This plate carries what are called pawls, which are free to move outwardly under centrifugal force. The car speed at which

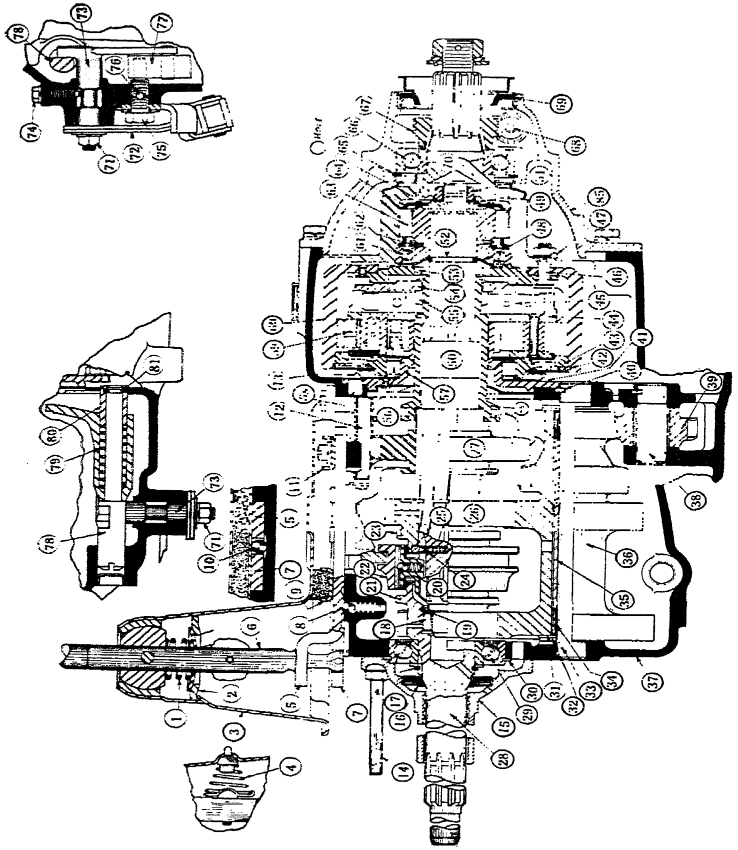


Fig. 20. Nash LaFayette Cruising Gear and Transmission Assembly
Courtesy of Nash Motors Company, Kenosha, Wisconsin

they move is controlled by springs. When the pawls move outwardly they engage with slots of another plate which is called the shell. The pinions, mentioned previously, rotate on shafts and these shafts are directly connected to the shell.

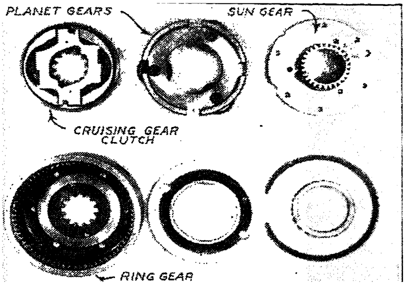


Fig. 21. Planetary Gear Units
Courtesy of Nash Motors Company, Kenosha, Wisconsin

The engine power comes from the transmission main shaft into the sliding shaft, from there to the clutch core, then through the pawls and shell to the pinions. The pinions, by virtue of turning around the sun gear, drive the ring gear; this ring gear being attached to the tail shaft, the power then flows to the propeller shaft.

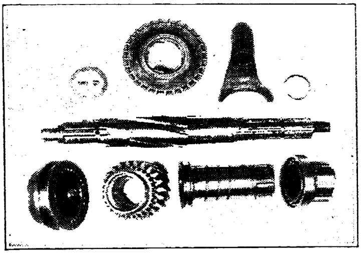


Fig. 22. Main Shaft of Synchro Clutch
Courtesy of Nash Motors Company, Kenosha, Wisconsin

An overrunning clutch, Fig. 22, is an integral part of the unit. The overrunning clutch must be employed to let the automatic centrifugal clutch function, because the automatic centrifugal clutch can function only at the time that the shell and transmission main shaft speeds are synchronous. There is a decided advantage in this, as below the car speed of 45 miles per hour, at which the automatic clutch engages overdrive, the car free wheels, which helps greatly in case of shifting. Above that speed and while in Cruising Gear the car does not free wheel. Fig. 23 shows the free wheel clutch.

The transmission is shifted in exactly the same way as formerly. The overdrive shift is made automatically, by simply lifting the foot from the accelerator for about 1½ seconds. The only manual control is the selector lever on the dash which positions the unit either for conventional drive or overdrive. When the unit has been selected, so that overdrive is locked out, free wheeling is also locked out.

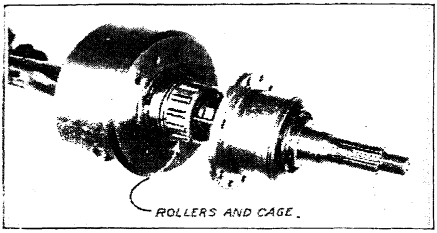


Fig. 23. Free Wheel Clutch
Courtesy of Nash Motors Company, Kenosha, Wisconsin

The operating characteristics of a car with Cruising Gear are as follows: the car is started and the transmission shifts are made just as normally into third or direct drive. The car can now be accelerated to its maximum speed in direct drive without the Cruising Gear becoming operative. However, if that acceleration is not needed, at 45 miles per hour or above, the foot is momentarily lifted from the accelerator, the Crusing Gear is then automatically engaged and remains engaged until the car speed falls to about 38 miles per hour. The car speeds at which the automatic clutch engages and disengages, are approximate, due to manufacturing tolerances of the governing springs. The adjustment for the Cruising Gear is shown in Fig. 24.

The ratio of the Cruising Gear is .705. With a 4.4 axle as on 3,580 this gives the effect of a 3.1 axle which will be recognized as rather fast. One might question the ability of the car in the Cruising Gear speed, especially on a hill. When a situation of this kind comes up, either of two things can be done: the transmission can be shifted into second speed while still in Cruising Gear, and thus give an overall ratio of 5.3 or, expressing it another way, it has the effect of a 5.3 axle in direct drive; or the transmission can be left in direct and when the car speed slows up, the Cruising Gear will automatically be disengaged, giving a 4.4 axle.

In bringing out this unit, the purpose was not primarily to increase the car speed, although this does ordinarily result. The evolution from "box bodies" to stream-lined ones—some radical, others not so much so—has resulted in every instance in an increase in engine revolutions. The purpose of Nash Cruising Gear is to decrease the engine revolutions for any given car speed, and at no sacrifice to ability. When this is done there are many favorable results to the car and driver.

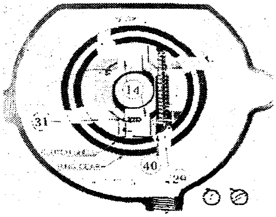


Fig. 24. Adjustments for the Cruising Gear
Courtesy of Nash Motors Company, Kenosha, Wisconsin

The great advantage of the Cruising Gear in conserving engine life is easily appreciated when it is realized that it reduces engine speed 30 per cent for a given car speed. This means that at 60 miles per hour the engine speed corresponds to 42 miles per hour; at eighty miles per hour, engine speed corresponds to 56 miles per hour, etc.

It is well known that axle ratios are compromised, usually being fixed to give satisfactory acceleration. When this is done, the ratio of engine speed to car speed is so high that the engine passes its peak horsepower long before the maximum car speed is attained. The Cruising Gear unit slows the engine speed down to the point where the maximum car speed occurs at near the maximum horsepower and thus is seen the paradoxical result of increased car speed with slower engine speed.

It is a well known fact that the faster an engine runs, the greater the load put on all bearing surfaces. Engineers figure that the loads on bearings increase as the square of the speed. Increased load means increased friction, with the result of wasted power and increased heat. Resistance of a bearing surface to wear decreases rapidly as the temperature rises. Thus the life of all bearing surfaces is increased tremendously by a reduction of the engine speed.

It has been explained how the Cruising Gear reduces the engine speed. Saying this differently, it takes 30 per cent less revolutions to go a mile. From this it is easy to understand the tremendous gain in piston, piston-ring and pin and cylinder-bore life.

In thinking about an automobile and its performance, the losses that are involved in such accessories as fan, generator, muffler, water pump and the like, are likely to be overlooked. These losses tend to increase roughly as the cube of the speed. For instance: if it takes 1 horsepower to drive the fan at 2,000 r.p.m., it would take 8 horsepower at 4,000 r.p.m. The overdrive not only reduces the engine speeds to more nearly the horsepower peak, but also reduces, of course, the speed of the different accessories and leaves the power ordinarily used by them available for driving the car.

Gas and oil mileage will increase with the use of the Cruising Gear. In their experiments Nash had as high as 28 per cent increased gas mileage.

One of the most important results is the human reaction. By reducing the engine speed at high car speeds, the overdrive likewise reduces the noises and vibrations caused by the reciprocating parts. When in overdrive, you will notice an apparent complete lack of engine and other noises. As an example, fan noise increases with speed in about the same proportion as does the power needed to drive it. The reduction in engine speed which the overdrive achieves, not only reduces the power losses, but also tremendously reduces the volume of noise.

Noise is, of course, tangible, but most hard to measure in its human reactions. It is well established that the tiresomeness of driving is not so much caused by the actual physical effort of driving, but is a nervous reaction caused by noises and vibrations. The passengers are almost as tired as the driver. It is particularly interesting to note the better time a driver makes on a long trip in a car equipped with Cruising Gear. This is not so much due to increased speed as it is to the fact that there is not so much driving fatigue and the driver maintains a better average, while probably driving some faster than he would in an ordinary car. This is truly relaxed motoring.

Lubrication. Transmissions equipped with Cruising Gear require special lubricant SAE-70 Plain Motor Oil, Low Cold Test, in both transmission and Cruising Gear.

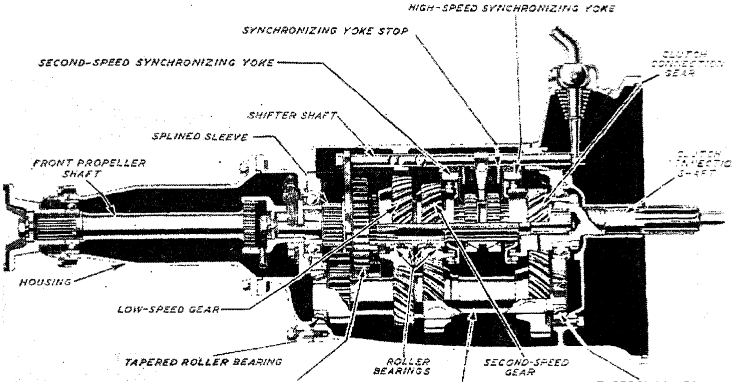


Fig. 25. Cadillac Rocking Yoke Syncro-Mesh Transmission
Courtesy of Cadillac Motor Car Co.

ROCKING YOKE TYPE TRANSMISSION

This synchro-mesh transmission, illustrated in Fig. 25, is used on the Cadillac 75, 80 and 85 automobiles. The synchronizing mechanism consists primarily of two cone type friction clutches, one for second gear and one for high gear. Each clutch consists of a sliding drum lined with bronze and a steel cone on the gear. Synchronization is not applied to low and reverse gears as shifting into these positions is required only when the car is standing still. The synchronizing drums are operated by yokes pivoted on eccentrics which are fastened to adjusting quadrants on the outside of the transmission case. Moving these quadrants up or down shortens or lengthens the yoke travel. The movement of the yokes is controlled by the cams machined on the shifter shafts. These cams engage the rollers of the two oil-controlled plungers in the yokes.

The helical gears are cut on an angle of 45 degrees. These are used on all forward speeds. This serves to effect quiet gear operation owing to the number of teeth in contact. Quietness of the transmission is further assured by the use of large, anti-friction bearings which are used to hold the gears rigidly aligned. The Cadillac automobile makes use of two propeller shafts, one of them being the enclosed propeller shaft which is shown at the rear of the transmission in a housing bolted to the transmission case. The length of this shaft extension depends upon the wheel base of the car. This housing extension is utilized to provide an additional point of support for the power plant.

Transmission Lubricant. Summer time lubricant recommended for the Cadillac transmission is S.A.E. 160 viscosity (A-200-E.P.). The E.P. Stands for extreme pressure. For winter time use an extreme pressure gear lubricant of S.A.E. 90 viscosity (A-9-E.P.). In case of unsatisfactory gear shifting, the first point to inspect for difficulty is the lubrication or the amount of lubricant in the transmission.

The lubricant level should be checked every three thousand miles of service. After the lubricant is added, ample time should be allowed before replacing the plug to let any excess lubricant drain out down to the level of the bottom of the filler hole. In case an over large amount of lubricant is used, pressure may build up within the transmission and force some of the lubricant into the clutch housings. It is advisable to have all old lubricant drained from the transmission at the beginning of warm weather and have the transmission serviced with the proper grade of lubricant for summer time operation. This is extremely important with reference to synchro-mesh transmissions as the lighter lubricant may affect the synchronizing mechanism and result in unsatisfactory gear shifting with gear clash.

TRANSMISSION TROUBLES

Transmissions Jumping Out of High Gear. In case of a transmission gear set which "pops out" of high gear under load, the first point to inspect for possible difficulty is that of the springs and pawls which notch into the shifter fork shaft. See that the springs are in good condition and that the shaft moves a proper distance to permit the pawl to engage in the notch. It sometimes happens that shifter forks are bent.

It is also important to check to see that the transmission is bolted to the flywheel in the correct manner. If there is any reason to believe that the flywheel housing and transmission bell housing do not mate and line up correctly, it is a good plan to true up the clutch and flywheel housing.

Trueing Up Housing. The clutch housing first may be trued by using a simple method of bolting a cutting tool to the face of the flywheel after the transmission and clutch have been removed from the car. The spark plugs are removed from the engine so that it may be turned over with the hand crank. A special form of refacing tool is needed for this work. After it has been aligned on the flywheel, a cut is started from the outside of the clutch housing face and the cutting tool fed across the housing face much after the fashion of hand feeding a cutting tool on the screw cutting lathe tool rest. In doing this work, set the cutting tool to find the lowest point of the housing so that it will just clean up the surface at that point. By taking very fine cuts with the tool, it will be possible to use the hand crank for power.

Adjusting Transmission Tapered Roller Bearings. Unless transmission shaft bearings are in proper adjustment, the gears may jump out of mesh. As a general practice, these roller bearings are adjusted by means of spacers on the transmission shaft between the two tapered roller bearings for each gear. When checking, make certain that the main shaft assembly locking device is securely tightened. Next, make certain that the tapered roller bearings are in proper adjustment. When adjusted properly, the low and intermediate gear should have a slight drag. If the bearings are found to be loose, it will be necessary to dress down both spacers between the bearings until a slight drag is felt on the gears. When dressing down these spacers, lay a sheet of emery paper or cloth on the surface plate or a piece of plate glass. Use the hand to move the spacer about on the emery surface, giving it a circular motion. Change the pressure on the spacer frequently by moving it under the finger tips. This will help to secure uniform grinding action. Prove the quality of your work with the micrometer, making certain that the spacer gauges the same thickness at all points. In case a spacer is dressed down too much, discard in favor of a new one. Continue the work until the proper adjustment of a slight drag is secured.

PACKARD EIGHT FOUR=SPEED TRANSMISSION AND CLUTCH

The motor unit includes the clutch and transmission assemblies enclosed in a housing attached to the rear end of the crank-case casting. The transmission case contains a selective gear set, giving four speeds forward and one reverse. The driving torque is transmitted to the spiral bevel driving gears in the rear axle through a shaft with a universal joint at each end. The final drive is through the differential and live axle shafts to which the rear wheels are keyed.

Action of Speed=Changing Gears. A splined driving shaft carries the low-speed gear *C*, Fig. 26, the second-speed gear *B*, and the third-speed driven gear. These gears are shifted to mesh with other gears on the countershaft to secure their respective speeds. For direct drive, the internal gear clutch *H* is shifted into mesh with the clutch gear *G*, thus coupling the clutch shaft and transmission driving shaft together. The sectional view of the transmission, Fig. 26, shows the gears in neutral position.

In this position with the motor running and the clutch engaged, all gears are in motion with the exception of the low-, second-, and third-speed sliding gears, which are fitted by means of splines to the main transmission driving shaft *D*. The forward end of the main sliding gear shaft is mounted in a roller bearing, located on the inside of the clutch shaft gear.

First speed is obtained by sliding the larger or first-speed gear *C* forward into mesh with the first-speed countershaft gear. This permits the car to be driven at the lower transmission gear ratio through the constant mesh gears at the front of the case and the countershaft and first-speed gears.

Second speed is obtained by sliding the intermediate or second-speed gear *B* forward into mesh with the second-speed countershaft gear. Third speed is obtained by sliding the third-speed sliding gear *A* to the rear to engage with the third-speed countershaft gear. Direct drive is obtained by sliding the driving clutch *H* forward until the internal teeth engage with the ends of the teeth *G* on the clutch shaft *F*, thereby locking both shafts together.

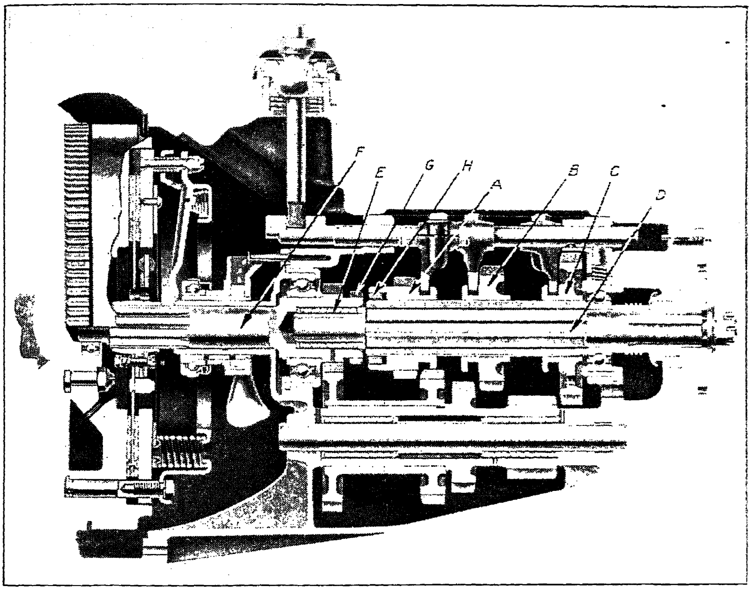


Fig. 26. Packard Four-Speed Forward Transmission Makes Use of Spur Gears

For reversing the drive, the intermediate transmission driving shaft gear *B* is brought back into mesh with the reverse idler pinion, which is in constant mesh with the small gear at the rear end of the countershaft. The drive is then through the constant mesh gears at the forward end of the transmission case, the countershaft, and the reverse idler pinion which is in mesh with both the countershaft gear and the driving shaft gear. This arrangement causes the main driving shaft to be revolved in the reverse direction.

While it is possible to shift from any one gear to another without going through an intermediate gear, it is necessary in each case to move the shifter lever through the neutral position. This brings the sliding gears out of engagement and in making the next shift the sliding gear that is not to be used is automatically locked in the neutral position. The position of the shift gear lever for each speed is shown in Fig. 27. A distinct advantage of this type of shift is the fact that reverse and second are in line with each other and can be used in rocking the car out of a mud hole when it is desired to use them similar to low or reverse of three-speed transmission.

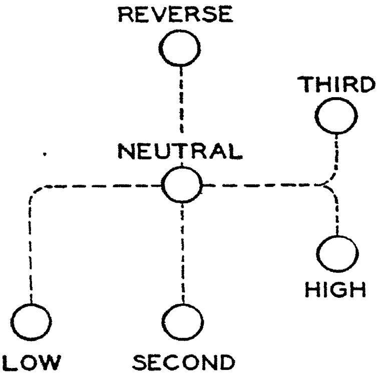


Fig. 27. Gear Shift Positions for the Packard Four-Speed Transmission

Cleaning the Transmission. It is a good plan to drain the oil from the transmission after about every 10,000 miles of running and to flush out the case with kerosene. The case should then be refilled to the filling plug level with good transmission fluid mineral gear oil. Cold weather has the effect of thickening the lubricant, and it should be diluted with from one-half to one pint of kerosene to bring it to its summer consistency. If the oil is too thick, difficulty will be found in shifting gears. With the return of warm weather, the transmission should be drained and refilled with oil of the original consistency. The drain plug is located in the bottom of the transmission case and the level plug on the right side.

REO SELF-SHIFTER OR AUTOMATIC TRANSMISSION

The Reo self-shifting transmission, shown in section in Fig. 28, incorporates a new feature which eliminates ninety per cent or more of all gear shifting through its automatic operation. In normal starting, the only manual operation is disengaging the clutch, moving the selector forward from the neutral position to forward position, and the engagement of the clutch in regular manner.

The automobile starts in the forward starting range through an internal gear reduction in the automatic unit of the transmission. As the car speed approaches approximately 14 miles per hour, the transmission smoothly and without an interruption in the steady flow of power changes into the direct or high gear drive. Should the car speed be retarded to a point slightly below 10 miles per hour, the transmission automatically changes back into the normal low gear with no effort of any kind on the part of the driver.

An auxiliary low gear is provided for starting on exceptionally steep grades or for slow, powerful lugging.

Operation. The selector at the instrument panel actually shifts the conventional gears, which may be noted in the forward half of the transmission in Fig. 29. In the normal forward position (selector at instrument panel), sliding gear *V*, Fig. 28, on the spline shaft slides over the main drive gear *X*, making a direct drive through these gears. The countershaft gears also move forward, but do no engaging. The power is then applied by the spline shaft direct to the center of the automatic unit, through its integral gear *P*. This gear is meshed with the slightly larger gear *R*, which in turn, through external teeth, meshes with the large main gear *Q*, which is directly connected to the propeller shaft and drives the automobile. This is the internal gear train through which all normal starts are made.

Around the circumference of the large drum *S*, are located eight governor weights *K*, which tend to move outward by centrifugal force as the car speed increases. At approximately 14 miles per hour, these weights do move outward, pivot at the forward end, and smoothly engage and lock the multiple discs *F* through the pressure plate *G*, such action causing the automatic unit to rotate with the spline shaft as a unit with no gear reduction, therefore placing the

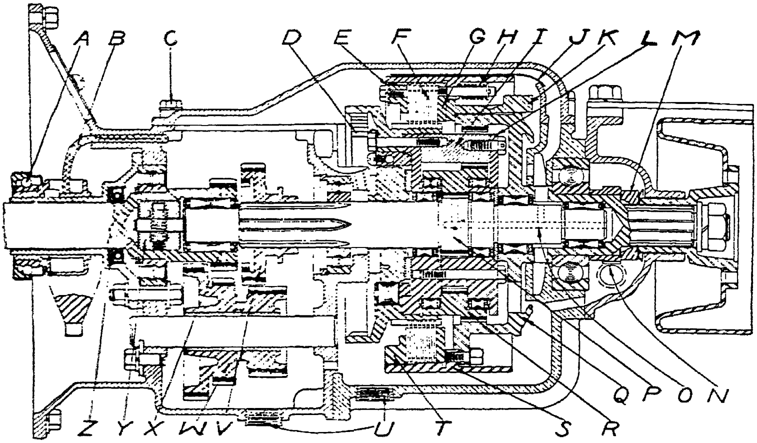


Fig. 28. Sectional View of Gear Set and Clutch Arrangement of Reo Self-Shifter Transmission. *A*—Clutch thrust bearing. *B*—Wick oiler. *C*—Venting cap screw, drilled. *D*—Inner drum. *E*—Lock plate, clutch adjusting ring. *F*—Multiple disc clutch. *G*—Pressure plate. *H*—Pressure plate return spring. *I*—Counterweight. *J*—Oil pick up and passage. *K*—Governor weight (8). *L*—Rear plate for eccentric assembly. *M*—Spacer. *N*—Speedometer drive. *O*—Oil passage in shaft. *P*—Internal gear on spline shaft. *Q*—Main gear. *R*—Rotating internal gear. *S*—Outer drum. *T*—Clutch adjusting ring. *U*—Drain plugs (2). *V*—Sliding gear. *W*—Countershaft gear. *X*—Main drive gear. *Y*—Synchronizing unit. *Z*—Grease retainer.

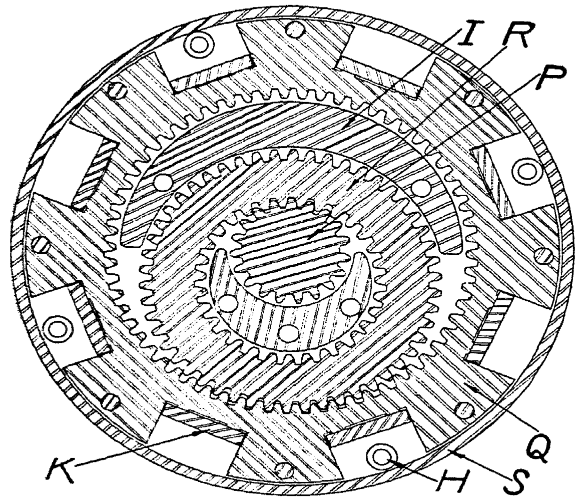


Fig. 29. Internal Gear Train (Letters correspond with Fig. 28)

transmission in high or direct drive. As the speed of the car is retarded below 10 miles per hour, the governor weights release the multiple discs, causing the driving to be done through the internal gear reduction.

In auxiliary low (selector moved straight back), the countershaft gears *W* are moved back, the forward gear meshing with the main drive gear *X*, and the second gear meshing with the sliding gear *V*. A reduction is then gained through these gears as well as the regular internal gear reduction in the automatic unit. When driving through these two reductions, and the car speed approaches approximately 15 miles per hour, the automatic unit changes into its own direct drive, then the drive is only through the forward gears. It will, of course, stay in these gears until the selector at the instrument panel is moved to the forward normal position, shifting the forward gears into direct drive.

In reverse (selector turned one-eighth turn clockwise in neutral and moved back), the sliding gear *V*, also the countershaft gears, are moved back, engaging through a reverse idler gear, which rotates the spline shaft in reverse. The drive in reverse is also through the internal reduction gears in the automatic unit.

Fig. 30 shows the cross section of the control mechanism and connecting cable in the neutral position. The selector, through the connecting cable, rotates the sector gear according to the various positions in the different gears.

Oiling System. The unit is oiled from a pick up *J* on the inside of the cover, forcing the oil to the rear and down through a channel into a sump surrounding the spline shaft. The spline shaft has a lead into the passage in the center *O*, which opens out at the internal gear mechanism. A portion of the oil from the cover is forced into a sump at the forward part of the assembly and is carried into the bearings at that point.

Lubrication. Drain and refill with new lubricant at the end of the first 1,000 miles, then each 3,000 miles thereafter. When draining, it is necessary to remove the plug *U* in the rear half of the transmission case as well as the one in the forward half. The capacity is three quarts. Maintain the level at the filler hole on the left side of the transmission case.

Lubricants. The lubricants recommended for use in this transmission are known as the E.P. (extreme pressure) oils. These were developed for use in free-wheeling units and are very high in lubrication value. For winter use free wheeling, S.A.E. 90 E.P. transmission oil. For summer use free wheeling, S.A.E. 90 E.P. except where extreme temperatures are experienced, for which S.A.E. 110 E.P. is recommended.

Lubricate the shifting mechanism at high pressure fitting on housing each 10,000 miles. Use fibrous lubricant. Lubricant applied at this fitting fills both shifting cable and shifting mechanism.

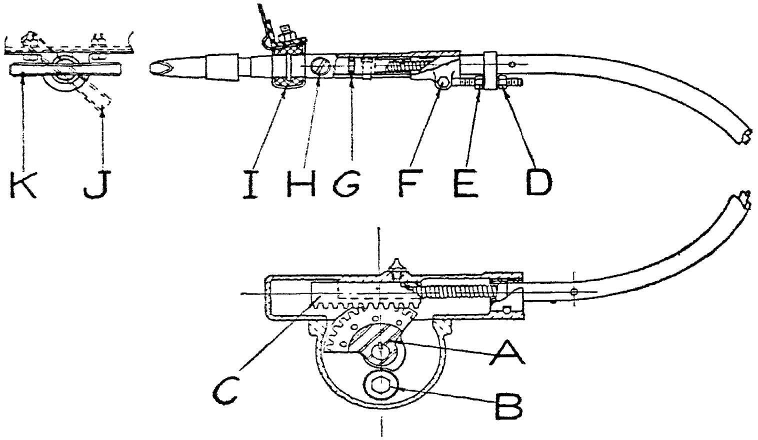


Fig. 30. Sectional View Showing Mechanism Operating Reo Self-Shifter Selector. *A*—Shifting sector gear. *B*—Reverse lockout plate. *C*—Rack for sector gear. *D*—Adjusting nut. *E*—Adjusting nut. *F*—Clamp bolt for tube. *G*—Notch in shifting rod for reverse and emergency low gear positions. *H*—Plunger, shifting rod lock. *I*—Rubber support at instrument panel. *J*—Selector position in neutral before pulling back into reverse. *K*—Normal position of selector.

The clutch release bearing receives its oil from a wick leading into the transmission case, as seen in Fig. 28 at *B*. The oils used are such that they feed to the throw-out bearing in sufficient quantities for proper lubrication.

FORD MODEL "A" TRANSMISSION

The Ford Model "A" transmission is of the standard selective sliding-gear shift type. All moving parts, with the exception of the reverse idler gear which is carried in a bronze bushing, rotate on ball and roller bearings.

How It Operates. When in low speed, the transmission low and reverse sliding gear meshes with the low-speed gear on the transmission countershaft gear assembly. In Fig. 31 the arrow traces the path of power transmitted.

In second speed, the intermediate and high sliding gear engages with the intermediate gear on the transmission countershaft gear assembly. In Fig. 32 the arrow traces the path of the power transmitted.

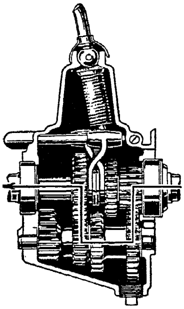


Fig. 31. Low Speed.

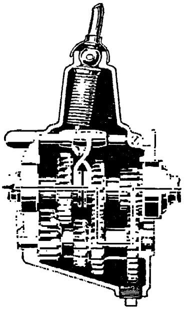


Fig. 32. Second Speed

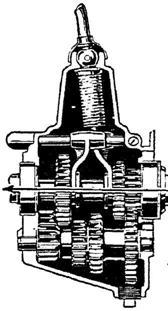


Fig. 33. High Speed

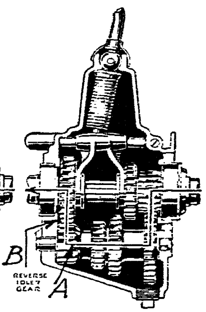


Fig. 34. Reverse

In high gear, the intermediate and high sliding gear engages with the transmission main-drive gear. In Fig. 33 the arrow traces the path of the power transmitted.

In reverse, the low and reverse sliding gear meshes with the reverse idler gear, which is in constant mesh with the rear countershaft gear. In Fig. 34 the arrow *A* traces the path of the power transmitted. The arrow *B* in Fig. 34 shows the position of the reverse idler.

FORD TRUCK FOUR-SPEED TRANSMISSION

The four-speed selective type transmission used in the Ford truck is representative of a more or less standardized practice for heavy-duty transmissions such as might be used in bus truck work, which requires transmissions heavier than those used in pleasure cars, but not as complicated as those used in the extremely heavy-duty field.

The type used in the Ford truck is illustrated in Fig. 35, where it will be noted that fourth speed or high speed is in the usual high-speed position, third speed is where the usual second-speed position is found, and the second speed is in the position usually occupied by first or low, while first speed is found in the position ordinarily occupied by reverse. Reverse, then, is found by pulling a gear-shift lever latch and throwing the shift lever ball on the far right over neutral and pulling back on it. These jobs are so designed that it is impossible to shift from neutral into reverse without first pulling the shift lever latch.

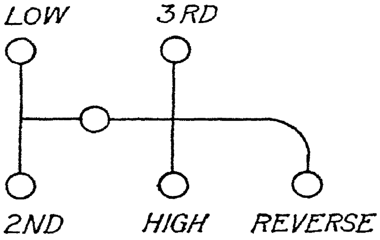


Fig. 35. Ford Four-Speed Truck Transmission Gear Shift Diagram

The gear shift is quite similar to the standard shift for a third-speed forward job, with the exception of first and reverse. The shifting operation, when driving, comes quite natural since first is not usually used in starting on a level street or with an unloaded truck. Starting in second, the drive follows through third and into fourth or high in a very natural manner.

Transmission Operation. By referring to Fig. 36, the several positions for the gear shift will be noted. A black line with an arrow indicates the flow of power from the front end to the rear end of the transmission. In the case of the first or low speed, power enters from the engine, goes into the main drive gear, and from it to the large countershaft gear, and thence through the countershaft, and from it through the large sliding gear of the transmission, and thence on to the rear end. The position of the gears in the case of second speed

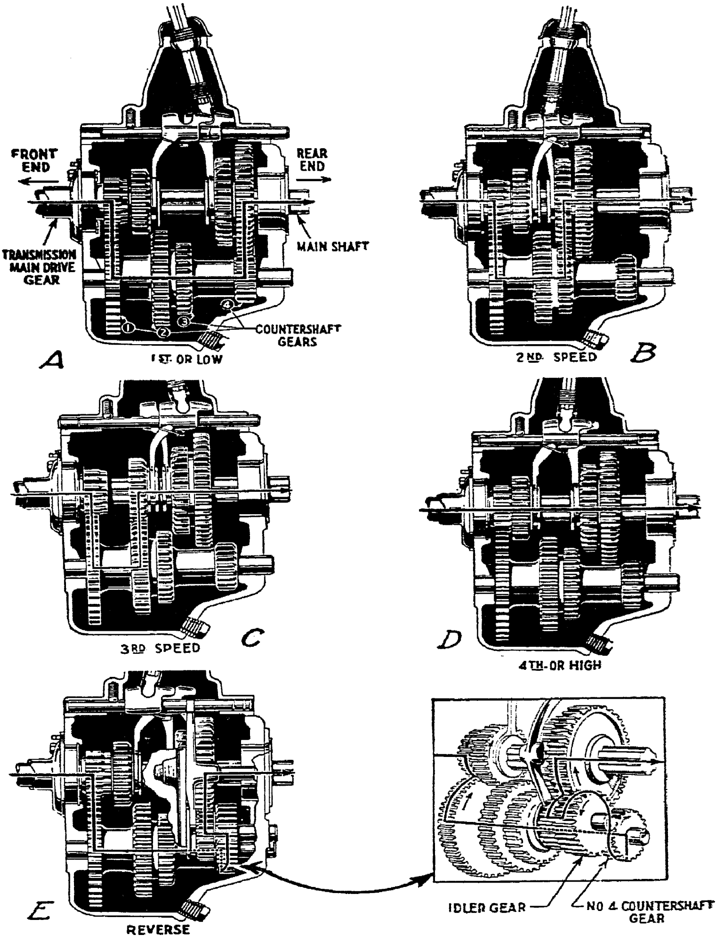


Fig. 36 Positions of Gears for All Speeds of the Ford Truck Transmission

is illustrated at *B*, and it will be noted that the gear-shift operation is quite similar to that for the third-speed forward selective transmission. At *C* the third-speed forward position is shown with the first- and second-speed sliding gears in neutral and with the third-speed sliding gear meshed with the second countershaft gear. Shifting into fourth or high, simply engages the high-speed gear clutch, and the drive is direct. When the shift into reverse is made, the reverse idler gear is shifted forward on the idler shaft, so that the power coming through from the engine enters the main drive gear and thence flows to number one countershaft gear, and then through to number four countershaft gear, and from that point into the reverse idler gear. The reverse idler gear delivers its power into the low sliding gear, which turns the main transmission shaft and drives the universal coupling and propeller shaft to the rear axle. This arrangement of parts is illustrated in the reverse position in Fig. 36. The numbers used with reference to the countershaft gears are shown at *A*.

FORD "V-8" TRANSMISSION

The Ford transmission, Fig. 37, is of the selective type with second gears in constant mesh. Quiet operation is obtained by the use of helical gears, and direct drive is used for high speed.

This transmission has a synchronizing device for quiet and easy gear engagement for second and high speed changes. The synchronizing device consists of a ring and hub. On the inside of the ring are teeth which engage with the teeth on the outside of the hub, so that these gears are in mesh at all times. When in neutral position, the ring is centralized on the hub by a number of balls which are held in a groove in the ring by springs, there being six of each. On each side of the hub is a bronze section which fits into a conical steel flange on either side of the second and high speed gears.

When it is desired to change gear for either second or high gear, the synchronizer moves as a unit and engages the bronze section of the hub with the steel flange of the gear. This contact, which is similar to the engagement of a cone clutch, makes the two revolve at the same speed or, to use the correct term, the two are synchronized and the movement of the gear is then completed by the releasing of the ring from its central position on the hub, so that the teeth on the ring engage with those on the second or high speed gears. As the high or second speed gears rotate at the same speed as the sliding ring, the change is made without any clashing or noise. Care should be taken in the use of a correct lubricant in this transmission, and it should be a fluid gear lubricant.

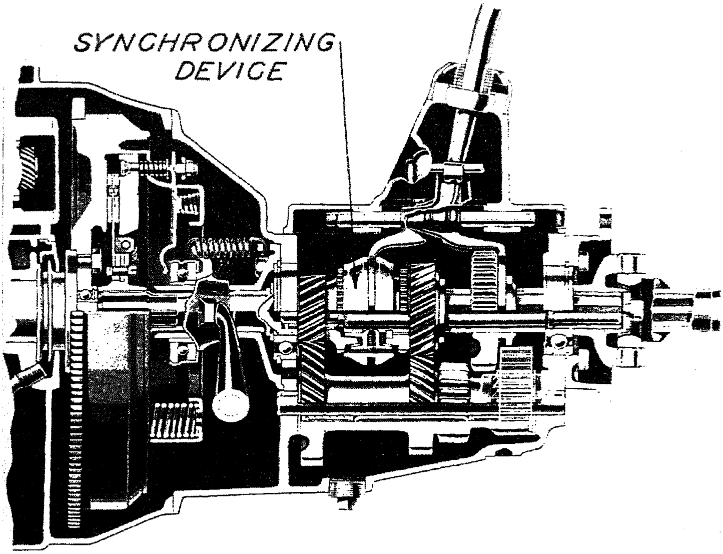


Fig. 37. Ford "V-8" Helical Gear Transmission with Synchronizing Device

SYNCHRO-MESH TRANSMISSION

The synchro-mesh transmission was developed to meet the need of a device which would make shifting of selective speed transmission gears easy and free from clash. The chief difficulty in shifting gears is securing proper speeds or matched speeds for the two gears which are to be meshed. Experience shows with any transmission gears there are times when a perfectly satisfactory and silent shift is made; while at other times, with the standard transmission, clashing results. This is due solely to the fact that the speeds of the gears being meshed were not synchronized or made the same or equal before the teeth were actually engaged with each other.

The synchro-mesh transmission is designed to fill this need. It synchronizes or makes even the speeds between the two gears which are to be engaged before they are actually meshed. The manner in which this is done is illustrated in Fig. 38.

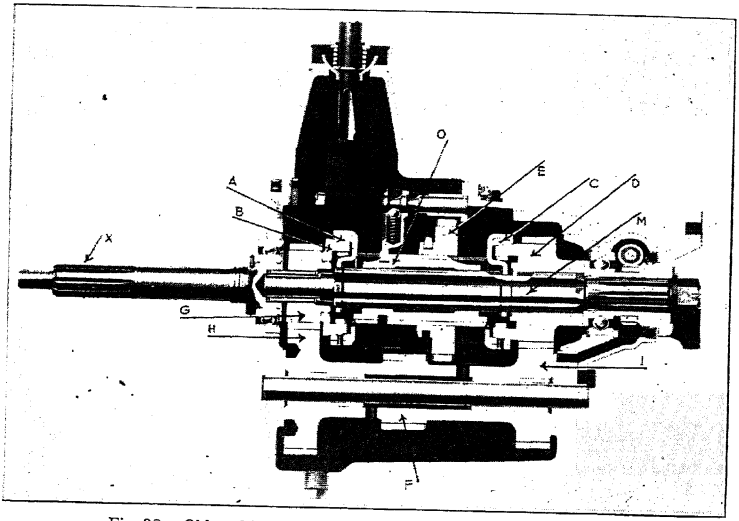


Fig. 38. Oldsmobile Constant Mesh Synchro-Mesh Transmission

This transmission incorporates constant mesh for the clutch shaft gear *G* and the jack shaft gear *H*, which is part also of the cluster gear *F* and *I*. That is, this cluster gear *H-F-I* is always turning on the jack shaft when the clutch is engaged and gear *G* is driving it. Furthermore the gear *D* is in constant mesh with the gear *I*, and this too is always turning when the clutch shaft is being turned. Naturally the speed of the gear *D*, which is second speed, is slower than that of the clutch shaft *X*.

With the constant mesh feature, then, it is necessary to shift the clutch dog unit *O* forward and engage with the clutch shaft gear *G* in order to secure high; and this same clutch dog *O* is shifted rearward to engage with the second speed gear *D* in order to secure second speed drive. It is in these two shifts that the synchro-mesh feature, as illustrated by *A* and *B* at the forward end of the transmission and by *C* and *D* at the rear end of the transmission, comes into play.

As a further lead in understanding the action of this and similar synchro-mesh transmissions, it should be pointed out that the clutch dog or sliding sleeve *O* is made up in such fashion that the end of it passes through the synchronizing members *A* and *C* when shifts are made. This is made possible because of the fact that both the sliding sleeve and the synchronizing members are mounted on the splines of the main transmission shaft *M*.

Now when a shift is made, the floating synchronizing member, mounted at each end of the sliding sleeve, is caused to rotate with the main shaft by means of three supporting arms, which engage the splines of this shaft. These arms are not as wide as the splines, thus permitting the slight angular rotation of the synchronizer, necessary at the time of synchronization so as to permit meshing the gears quietly. The synchronizer members also incorporate a bronze ring with a taper seat, which, when the member is shifted endwise slightly, engages a corresponding ground taper seat on the clutch gear for the shift into "high" or on the floating idler on the main shaft for the shift into "second." These taper seats permit a clutch action between the two surfaces much like the old cone clutch construction, so that the desired gear is slowed down or stepped up, as the case may be, to the speed of the main shaft, which, of course, depends upon the car speed at the time.

This first step towards synchronization brings the synchronizer cone clutch into action when the sliding sleeve is shifted endwise. Further movement of the sleeve causes a jaw clutch, with angular faces, at the end of the sleeve to engage similar angular faces in the synchronizer web, thus rotating slightly the gear which has been picked up by the taper seat, at the same time the sleeve is being moved still further endwise. This action facilitates the positive meshing of the external teeth on the sleeve with internal teeth cut in the two synchronized gears. At the end of the synchronizing movement there is a space on the one gear directly opposite each tooth of the mating synchronized gear, so that the final shifting is quietly performed. The meshing of internal and external teeth mentioned is equivalent to an end jaw-clutch with a large number of small teeth, instead of a few "jaws." The internal gear has the same number of teeth as the external teeth on the sliding sleeve and they are both concentric.

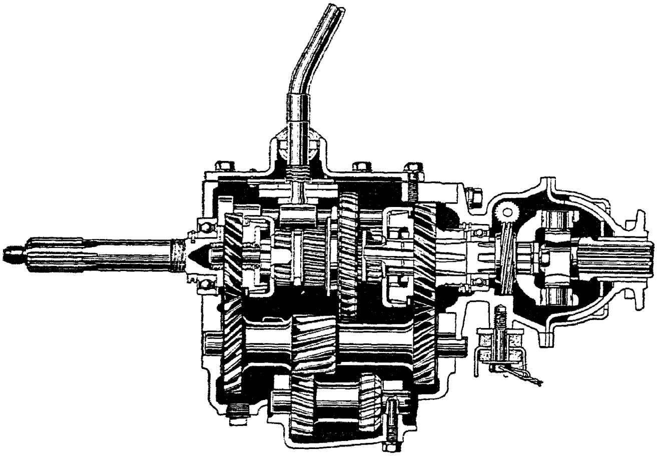


Fig. 39. Buick Synchro-Mesh Helical Gear Transmission

BUICK SYNCHRO-MESH TRANSMISSION

Transmission—Series 40. The Buick synchro-mesh transmission, Fig. 39, is the selective type with three speeds forward and one reverse. All gears have helical teeth for quiet operation. With the car in motion when the shift is made, the movement of the parts in shifting from neutral to intermediate are as follows: The sliding sleeve and the synchronizing drums are revolving in unison. Movement of the control lever "with clutch disengaged" moves the sliding sleeve and the three flat detent springs (located between the sleeve and the splined shaft) endwise until the ends of the springs contact the drum and move it into engagement with the cone of the intermediate speed gear.

At the instant of engagement between the drum and cone, the friction rolls the drum relative to the sliding sleeve until the cam faces of the drum and sliding sleeve contact. Pressure exerted upon the second speed gear cone, by the friction drum through the cam faces, will cause the second speed gear to revolve at the same speed as the sliding sleeve and permit their engagement without clashing.

Construction Details. The transmission case and cover are of cast-iron, and the case is accurately aligned and piloted to the flywheel housing. The clutch gear is supported in two ball bearings. The one at the forward end is in the crankshaft, and the one at the rear is a shielded type supported in the front wall of the transmission case and arranged to take the thrust caused by the helical gear teeth. The counter gear has its three gears integral and is supported in a stationary countershaft in bronze bearings. The counter gear end thrust is taken in the bronze washers at each end. A scoop is provided in the hub of the counter gear to take oil into the shaft where it is fed through the bushings to the thrust washers in either end.

The transmission main shaft, having six accurately machined helical splines to insure a good fit of the sliding sleeve, is supported at the rear by a ball bearing arranged to take the end thrust of the gears, and by a roller bearing in the clutch gear. The second speed gear at the rear of the case is free to revolve on the main shaft and its thrust is taken on thrust washers fixed to the main shaft.

The reverse idler gear is supported on a stationary shaft on bronze bushings and the thrust is taken by bronze thrust washers at either end of the gear. The first and reverse sliding gear is mounted on the helical teeth of the sliding sleeve, sliding forward for the first and rearward for reverse.

The sliding sleeve is carried by the main splined shaft. This sleeve has external helical teeth that engage the internal helical teeth which in turn engage the internal helical teeth of the clutch gear, or the second speed gear. At each end of this sleeve are cam surfaces that contact like surfaces on either the direct or intermediate synchronizing drum at the time of shift from neutral to direct or to intermediate speed.

Improper Synchronization. If the transmission fails to synchronize properly, check as follows: It is essential for the clutch to release completely to obtain satisfactory synchronization. Check for release by depressing the clutch pedal and shifting the transmission into reverse or low speed. This should be accomplished without gear clash when the car is not in motion.

Any dirt within the transmission may prevent the proper functioning of the synchronizing unit by scoring the bronze cones or sticking the flat detent springs to the splined shaft. Thoroughly flush the transmission with kerosene and refill with clean oil. Do not run the engine more than two minutes with kerosene in the transmission.

Improper lubrication retards synchronization. Use gear lubricant conforming with S.A.E. specifications No. 160 for summer and No. 90 for winter. Inspect frequently as oil should be maintained to proper level. If these tests have been made and the transmission still fails to synchronize satisfactorily, it must be removed from the car for further inspection. Proceed as follows: Remove the transmission cover and interlock plates. Clean the transmission thoroughly with kerosene. Examine all parts for freedom of operation. While holding the main shaft, turn the clutch gear, which should turn freely. Examine the sliding sleeve to see if it is free on the splined shaft. Examine the ends of the flat detent springs to determine whether they are in their proper position and not bent or broken. Inspect the synchronizing drums. They must be held in position by their respective snap rings and should have a free endwise movement of approximately 1/32 inch. If the cause for failure to synchronize is not apparent, it will be necessary to disassemble the transmission. Follow carefully the instructions for disassembling, and check the fits of the various gears, bushings, etc., with mating parts.

Disassembling the Transmission. Remove the transmission cover. Remove the interlock plate and shift bar. Remove the shifter shafts and forks. Remove the cap screws at the rear bearing retainer and turn the retainer clockwise, unlocking the counter gear shaft. Drive the counter gear shaft through the rear of the transmission to allow the counter gear assembly to drop to the bottom of the case. Remove the universal joint ball and end plate assembly from the back of the transmission. (While removing this assembly, hold the low and reverse speed gear, as it will not pass through the back end of the case.) Pinch together the prongs on the main drive gear bearing snap ring and tap the main drive gear out through the back of the transmission. Remove the counter gear and thrust washers. Remove the lock screw at the lower left rear corner of the transmission to permit the removal of the idler gear shaft, idler gear and thrust washers.

To disassemble the second speed gear remove the sliding sleeve and flat detent springs from the splined shaft. Remove the synchronizing drum snap ring and slide the drum off the end of the shaft. Disassemble the universal ball, remove the universal joint and press the splined shaft out of the front yoke of the joint and bearing in the end plate. The second speed gear may now be removed from the rear end of the splined shaft.

To disassemble the main drive gear assembly, remove the snap ring from the high speed synchronizing drum, remove thrust nut which has a left-hand thread and remove the bearing by bumping the shaft on a block of wood or piece of lead.

Assembling the Transmission. During the disassembly or subsequent assembly of the transmission, care must be exercised to prevent scoring or bruising of any part. Nicks in the gear teeth are certain to cause noise. Nicks in either bronze or steel cones prevent proper synchronization. All dirt or foreign substance of any nature must be excluded from the transmission to prevent abnormal wear of annular bearings, bronze bushings, and all synchronizing parts.

The teeth of all gears should show no pitting. Bearings must be "free turning" and free from score marks on either raceways or rollers. Before assembly all bearings should be thoroughly washed in clean gasoline or kerosene, blown out with compressed air to free them from any grit or foreign particles, and then spun to see if they roll freely. The direct and intermediate speed clutch must slide freely on the shaft. The bronze cones must be smooth and free from scores, and the oil grooves must be clean. The bronze cones should show the heaviest contact on their large diameters to give best results when synchronizing. For the main part the Buick transmissions are similar.

PONTIAC AND CHEVROLET SYNCHRO-MESH TRANSMISSIONS

The transmission, Fig. 40, incorporating the synchro-mesh principle, in operation, permits even inexperienced drivers to shift gears smoothly and noiselessly. The design is the selective type with three speeds forward and one reverse. The first and reverse speeds are conventional sliding gears. The second speed gears are in constant mesh and have helical cut teeth for quiet operation.

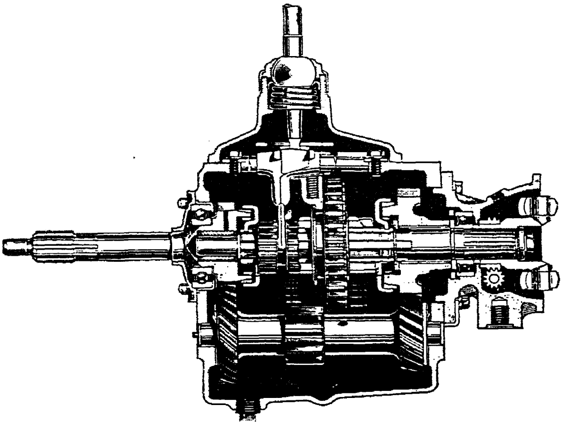


Fig. 40. Sectioned View of Transmission

The second speed constant mesh gear is mounted at the rear of the spline shaft, next to the rear bearing to insure greater rigidity. Between this second speed gear and the main drive (high speed) gear, is a sliding clutch sleeve, which is splined and fits over the spline shaft. This sleeve permits engagement into either second or high speed gears. The sliding clutch sleeve has three lugs at either end with cams at the corners of each lug which engage with corresponding cams on the synchronizing drum.

The synchronizing drum consists of a steel stamping loosely splined to the spline shaft by means of three legs which include the synchro-mesh servo-cams. A bronze internal cone is pressed into this stamping which engages with a corresponding external cone integral with the gear to be engaged. When the sleeve is moved towards either gear by means of the gear shift lever, the clutch sleeve teeth engage the cams on the lugs of the sliding sleeve contacting the servo-cams on the drum legs, causing the drum cup to be pressed against the gear cone. The frictional grip between these two surfaces then compels either the faster or slower turning gear sleeve to assume the same rotative speed as its mating gear. When this is accomplished, the frictional pressure is released. The clutch teeth can then fully engage with each other without clash.

To insure the cams of the sleeves making contact with the servo-cams on the synchronizing drum, a barrier, which is called a synchronizing spring, is placed between the sliding clutch sleeve and the synchronizing drum. As the sliding clutch sleeve is moved toward the gear to be engaged, it first meets the pressure of the synchronizing spring. This causes the synchronizing drum to be squared up and pressed against the external cone on the gear, and this initial pressure causes the drum to rotate sufficiently to bring the servo-cams into positive alignment. After the servo-cams have made contact, further movement of the clutch sleeve causes the synchronizer springs to enter the counter-bored ends of the clutch sleeve, thereby offering no further resistance to motion of the clutch sleeve. The transmission gear ratios are—high 1:1; second, 1.70:1; low, 3.02:1; and reverse, 3.40:1.

The sequence of events during gear engagement is as follows: First, the clutch sleeve moves by means of the gear shift lever, taking up end clearance. Second, the clutch sleeve makes contact with the synchronizing spring, which forces the synchronizing drum against the cone on the gear. Third, the rotation of the drum brings the servo-cams into contact with the bevels of the clutch sleeve. Fourth, the servo-cams press the synchronizing drum against the external cone on the gear, forcing the gear to assume the same rotative speed as the engaging teeth on the clutch sleeve, while preventing further movement of the clutch sleeve. Finally, the clutch teeth having assumed the same rotative speed, the synchronizing drum pressure is released, permitting the engaging teeth to float and slide into each other easily.

Caution. Car owners should be instructed to shift gears slowly, as too rapid engagement does not allow the gears time to synchronize properly and gear damage may result. Gear shifting is best accomplished by a continuous and even pressure on the shift lever.

Removing Transmission from Chassis. Remove the front seat cushions. Remove the floor and toe boards. Disconnect the hand brake lever and speedometer cable, etc. Remove the cap screw from the rear engine support. Place the jack under the rear of the engine and raise the engine approximately 1¼ inches or until the engine is within ⅜ inch of the accelerator cross shaft linkage. Disassemble the universal joint ball and slip the ball housing back on the torque tube. Separate the universal joint, permitting the torque tube to drop down on the frame cross member. Remove the transmission to the clutch housing cap screws and pull back the transmission to clear the clutch shaft and remove from the top.

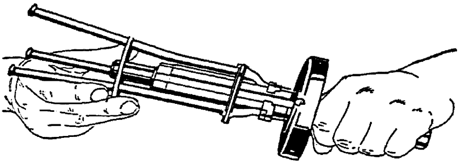


Fig. 41. Removing Synchronizing Spring with Special Tool

Disassembling the Transmission. Remove the transmission cover, interlock and shifter fork assemblies from the transmission. Remove the speedometer driven gear and shaft if replacement is necessary. Remove the front universal joint yoke with front ring and trunnion bearings. Remove the torque ball retainer screws. Drive out the countershaft from the rear to the front. Remove the torque tube ball retainer, spline shaft, second speed gear with synchronizer drum, and clutch sleeve as an assembly. The first speed gear must be removed through the upper opening in the case. The spline shaft pilot bearing and spacing ring, front synchronizer drum and front synchronizer spring should also be removed through the upper opening. Remove the clutch sleeve from the spline shaft and press of the transmission rear main bearing. Remove the lock ring holding the rear main bearing to the torque ball retainer and remove the oil sleeve and bearing. Remove the second speed gear from the spline shaft, and remove the rear synchronizing drum spring from the spline shaft, Fig. 41. Remove the second speed synchronizing drum thrust washer retainer and thrust washer from the spline shaft. Remove the lock ring holding bearing to the main drive gear and press bearing from the gear shaft. Remove the countershaft gear set and thrust washers from case. Drive out the idler gear expansion plugs, remove the idler gear shaft lock screw, drive idler shaft from front to rear and remove the idler gear from the case.

Inspection of Transmission Parts. Check the countershaft and bushings for wear and see that the bushings are in proper place in gear. Check the idler shaft and bushings for wear. It is usual for the shaft to show more wear than the bushings. Check the second speed gear bushing for wear. Inspect all gears for chipped, cracked, or worn teeth. Inspect the fit of the splines on the clutch sleeve with the internal teeth of the main drive gear. Inspect the fit of the splines in the clutch sleeve on the spline shaft. Check the fit of the splines on the clutch sleeve with the internal teeth of the second speed gear. Check the second speed gear thrust washer for wear. Check the fit of the splines on the clutch sleeve with the splines in the first speed gear. Check the notches for the shift fork shafts in the case for snug side fit of shafts. Wash all the bearings in clean kerosene. Oil the bearings with light oil and check for wear, cracked balls or roughness.

Removal and Replacement of Bushings. When necessary, remove idler gear, countershaft and second speed gear bushings, replacing them with new bushings. The two bushings used in the countershaft are different. They must be assembled in their proper places, i.e., front to front and rear to rear. The size of the front bushing is 1 inch O.D. x 1½ inch length. The size of the rear bushing is 1 inch O.D. x 1⅜ inch length.

Assembling the Transmission. Place the idler gear in the case. Assemble idler gear shaft from the rear of the case; line up the hole in the idler gear shaft with the hole in the case and assemble idler gear lock screw and tighten securely in place. Lubricate the countershaft gear thrust washers with heavy oil and assemble them to the case. Line up the raised part of the washers with cutout in case; place countershaft gear in case, allowing it to rest on the bottom. Assemble the oil slinger and bearing to the main drive gear, supporting the bearing at the inner race during this operation. Lock the bearing in place with the lock. Assemble the main drive gear and bearing to the case and assemble the main drive gear bearing retainer to the transmission.

When assembling the main drive gear to the transmission, tap on the bearing outer race and not on end of the gear. Tapping on the end of the gear may drive the gear through the bearing, making the oil deflector loose and causing a rattle. The main drive gear bearing retainer is marked "top." Make sure this is toward the top. Assemble the spline shaft pilot bearing in the main drive gear. Dip the bearing in the transmission oil before assembling. Assemble the front synchronizing drum to the cone on the main drive gear. Assemble the second speed gear thrust washer to the spline shaft, locking it in place with the retainer, and assemble the rear synchronizing drum to the spline shaft.

It is important to check the rear synchronizing spring across the three slots, with the micrometer. Make a note of the size because this dimension determines the proper clearance between the synchronizing drum and the cone. Assemble the rear synchronizing spring to the spline shaft. This spring is about 1/16 inch wider in slots than the front springs. Expand spring so it will slip over the shaft. Use special tool HM-520.

Assemble the second speed gear to the spline shaft and drum. With the second speed gear pressed against the thrust washer and the synchronizing drum pressing against the cone, check the clearance between the spring and the spline shaft shoulder. This must not be under .025″ and not over .035″. If this dimension is not within these limits, change the spring until it is. Various sizes of springs may be secured. The rear synchronizing springs can be identified by the following colors and sizes: White—.282″ wide in slots, Group 4.400, Part 590559; Black—.292″ wide in slots, Group 4.400, Part 590560.

Assemble the bearing to the torque tube ball retainer, placing the oil seal side toward the transmission side. Assemble the oil sleeve and bearing lock ring, making sure that the bearing lock ring is seated in the machined groove in the case. Assemble the rear thrust washer to the inside of the oil sleeve with the grooves facing the second speed gear. Assemble the spline shaft and second speed gear. Assemble the spline shaft to the torque tube ball retainer and bearing. When performing this operation, make sure that the legs on the drum line up with the slots in the rear synchronizing spring. Assemble the clutch sleeve to the spline shaft, aligning the slots in the sleeve with the legs on the drum. Check the size of the front synchronizing spring. Make a note of its size, because this dimension determines the proper clearance between the synchronizing drum and the cone.

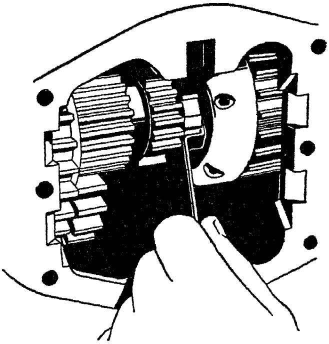


Fig. 42. Checking Clearance Between Synchronizing Spring and Spline Shaft Shoulder

Assemble the front synchronizing spring to the spline shaft. This spring is about 1/16″ smaller in slots than the rear spring. Make sure that the prongs of the spring face the sleeve. Insert first speed gear into transmission case with fork channel to front. Assemble spline shaft and torque tube ball retainer into transmission and first speed gear. Make sure that the notches in the sleeve line up with the legs on the front drum. After bolting the torque tube ball retainer securely to the transmission case, drive in the idler gear shaft hole expansion plugs.

Check for clearance between the front synchronizing spring and the spline shaft shoulder as shown in Fig. 42. This must not be less than .025″ and must not be more than .035″. If this dimension is not within these limits, change the front spring until it is. The front synchronizing springs can be identified by the following colors and sizes: Red—.173″ wide in slots, Group 4.400, Part 590571; Yellow—.183″ wide in slots, Group 4.400, Part 590572; Green—.193″ wide in slots, Group 4.400, Part 590573; Blue—.203″ wide in slots, Group 4.400, Part 590574; Brown—.213″ wide in slots, Group 4.400, Part 590575.

When changing the front synchronizing spring to secure the proper size, it is only necessary to remove the main drive gear. Lift up the countershaft gear, align the front thrust washer, insert the shaft and push it to the rear by hand. Align the rear thrust washer and drive in the countershaft, using a lead hammer. Assemble the front universal joint yoke. Never drive the front universal joint yoke into place as the synchronizer thrust washer will be ruined.

Assemble the shifter forks to the shafts. The notches on the second and high speed gear shaft go to the front, while the notches on the first and reverse speed shaft go to the rear. When assembling the shafts to the forks, assemble the spring and ball into position. Insert the shaft and turn it to force the ball and spring down. Then push the shaft to the center slot which is the neutral position. Assemble the reverse and first speed shifter fork and shaft and the second and high speed shifter fork and shaft to the transmission. Lock both the shafts in position, using the large lock at the rear and the small lock at the front. Be certain that the clamps hold the shafts down securely. Check the shifter forks for free movement. Assemble the cover to the transmission.

SHIFTING HELICAL GEARS AND SPIRAL SPLINE TRANSMISSION

The use of helical gears in rear axles has long since supplanted the use of the straight tooth bevel gears. The drawback, which for many years prevented the use of helical gears in transmissions, was the likelihood of the side strain on the gear which would cause it to be thrown out of mesh with its mating gear. This drawback has been overcome by the introduction of a spline on the main transmission shaft. The spline has exactly the same spiral pitch, or angle, that is used for teeth of the helical gears, so that the strain set up on the teeth is exactly offset by the spiral on the spline. The gear not only remains in perfect alignment with its mating gear without-side pressure, but an added advantage accrues owing to the fact that it is possible to use this arrangement of helical gears for the sliding gear set, so that the sliding gears are actually helical gears and the very nature of the helical gear tooth makes it easy to mate a pair of helical gears when shifting.

The application of the helical gear and spiral spline to the Chrysler car is shown in Fig. 45.

CAM AND ROLLER TYPE OF FREE-WHEELING UNIT

The cam and roller type of free-wheeling unit is illustrated in cross-sectional view in Fig. 43. In this view it will be noted that an arrow indicates the direction of rotation of the outer shell, marked *C*. As this shell is turned by suitable connection to the engine it tends to roll the three sets of four rollers each forward on the inclined plane with the result that they lock the outer shell to the inner core, marked *A*. (Tapered portion of inner core is shown at *B*.) This has the desired effect of causing the unit to revolve as one.

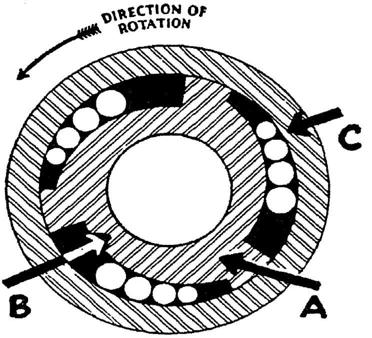


Fig. 43. *A*—Inner Core Coupled to Drive Shaft
B—Tapered Portion of Inner Core
C—Outer Casing Coupled to Engine

When the transmission is placed in the free wheeling position and the car is driven, the engine will propel the car as long as the engine speed is greater than a relative car speed. However, if the foot of the driver is removed from the accelerator, the result is that the engine will slow down, and in that case the inner core *A*, Fig. 43, will tend to turn faster than the outer shell or casing *C*, with the result that the sets of rollers are allowed to come away from close contact with the shell and core and the inner core then revolves at a greater rate of speed than the outer shell *C*.

This device is simply an overrunning clutch and serves to transmit drive in the direction the engine is turning as long as the engine speed is greater than a relative car speed. Thus in slowing down, if the engine speed is allowed to slack off, the car speed will slack off more gradually, with the result that an overrunning condition is maintained in the free-wheeling unit.

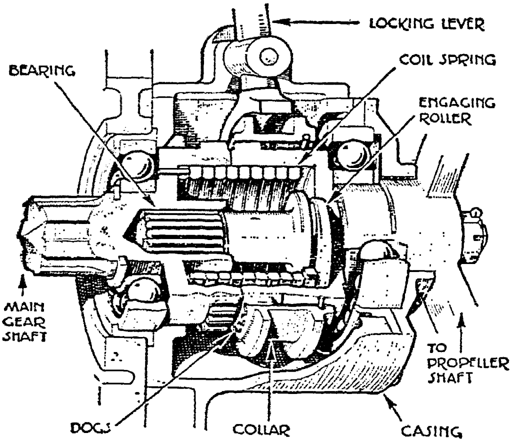


Fig. 44. L.G.S. Free-Wheeling Device in Sectional View

L.G.S. FREE WHEELING AS APPLIED TO AUBURN AND CHEVROLET AUTOMOBILES

The principle of operation of the L.G.S. free-wheeling device, which is bolted immediately to the rear of the transmission housing, is illustrated in Fig. 44. Here it will be noted that the main gear shaft carries within it the forward end of a shaft in a bearing and has an enlarged section within which is the forward end of a coil spring. Matching the hollow enlarged end of the main gear shaft is another hollow shaft covering the rear of the coil spring. On the outer surfaces of these hollow shaft ends are teeth and over these a collar having within it teeth. This collar is designed to be shifted so that when it is shifted towards the front, it serves to lock the two hollow shaft ends together thus causing them to rotate as one.

When "locking out" free wheeling, it is necessary to bring the engine speed up so that it is driving the car; then disengage the clutch before pulling out the control button, otherwise the teeth on the sleeve will clash badly and the car would be subjected to a severe load.

Caution. The motive power, which when in conventional drive, acts as a brake, is disconnected when using the free-wheeling device, therefore, never use free wheeling when driving in hilly country or on icy or wet pavements.

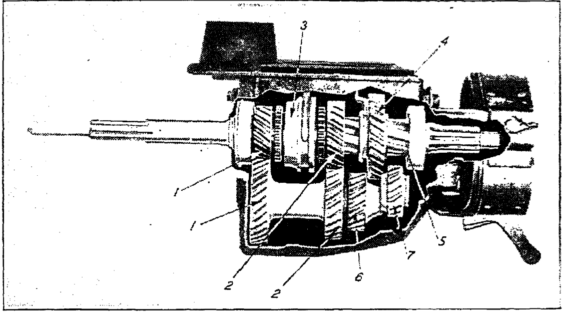


Fig. 45. Chrysler Synchro-Silent Transmission

CHRYSLER SYNCHRO-SILENT TRANSMISSION

Fig. 45 illustrates the Chrysler 1935 Synchro-Silent Transmission. The constant-speed gears *1-1* and the second-speed gears *2-2* are in constant mesh. The synchronizing device *3*, consists of a hub and ring. Teeth on the inside of the ring mesh with teeth on the outside of the hub at all times. When a shift is made to either high or second, the synchronizing device moves as a unit toward the gear to be engaged. The speed of the hub is synchronized or made uniform with the speed of the gear by means of a conical clutch. The internal gear or ring of the synchronizing unit is then released from its centrally located position on the hub and the teeth engage in the teeth of the high or second-speed gear. Since the conical clutch assures the two being rotated at the same speed, meshing of these gears is effected without clashing of teeth.

A further study of the illustration shows that the low- and reverse-shift gear *4* is mounted on the main shaft *5*, on spiral splines. This offsets the tendency of the helical gear teeth to come out of mesh when they are placed under load. It will be further noted that the low-speed gear *6* and the reverse-speed gear *7*, are also of the helical type. This makes for quiet operation in all speeds.

A brake drum is carried on the rear end of the transmission shaft and is used in connection with the hand brake for parking or emergency stops.

HUDSON-BENDIX ELECTRO-VACUUM TRANSMISSION CONTROL

The "Electric Hand." A selective transmission has 2 shifting rails, each having a neutral, a forward, and rearward position. The selection of the proper rail is obtained by moving the shifting lever sideways to engage a slot in the fork of the rail desired, after which, movement of the rail and gear engagement is obtained by moving the shifting lever forward or backward. These same operations are performed by the Electric Hand.

The diaphragm cylinder, Fig. 46, contains a spring which presses forward, holding bellcrank *F* in the position shown, so that the shifting lever is held to the left in engagement with the slot in the fork of the high and second shifting rail. By admitting vacuum to the rear of the diaphragm it is moved backward, rotating *F* clockwise, drawing lever *G* to the right, and bringing the shifting lever into engagement with the slot in the fork of the low and reverse shifting rail. The vacuum connection, Fig. 47, is shown from the diaphragm cylinder to the valve controlled by solenoid No. 3. The plunger *22*, is held in the upward position by its return spring, the vacuum from the engine is cut off and the atmospheric vent is connected below the plunger to the diaphragm cylinder line, allowing the spring *Y* to force the diaphragm forward.

When the solenoid is energized, the plunger *22* is drawn down,

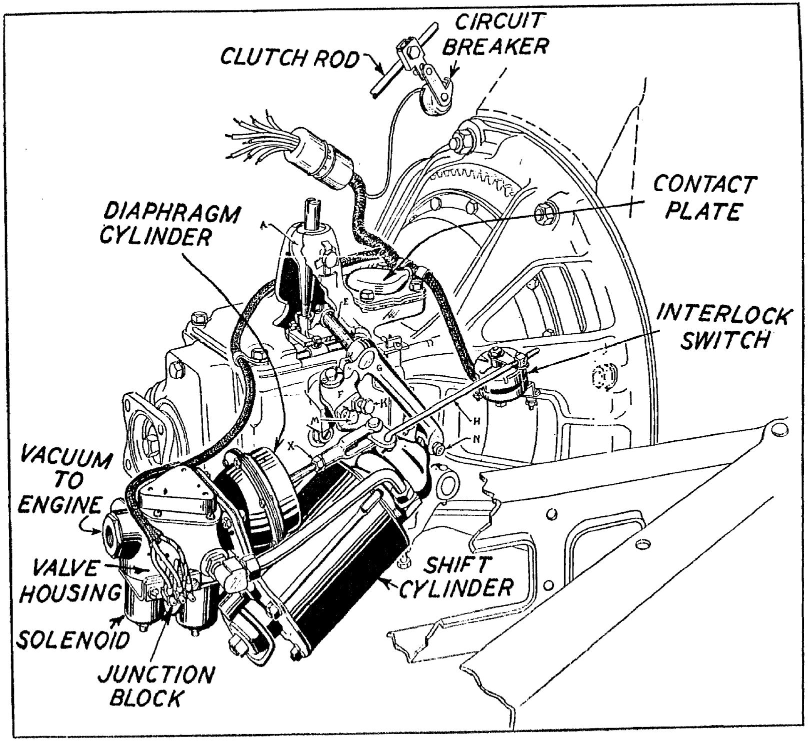


Fig. 46. The Hudson "Electric Hand"

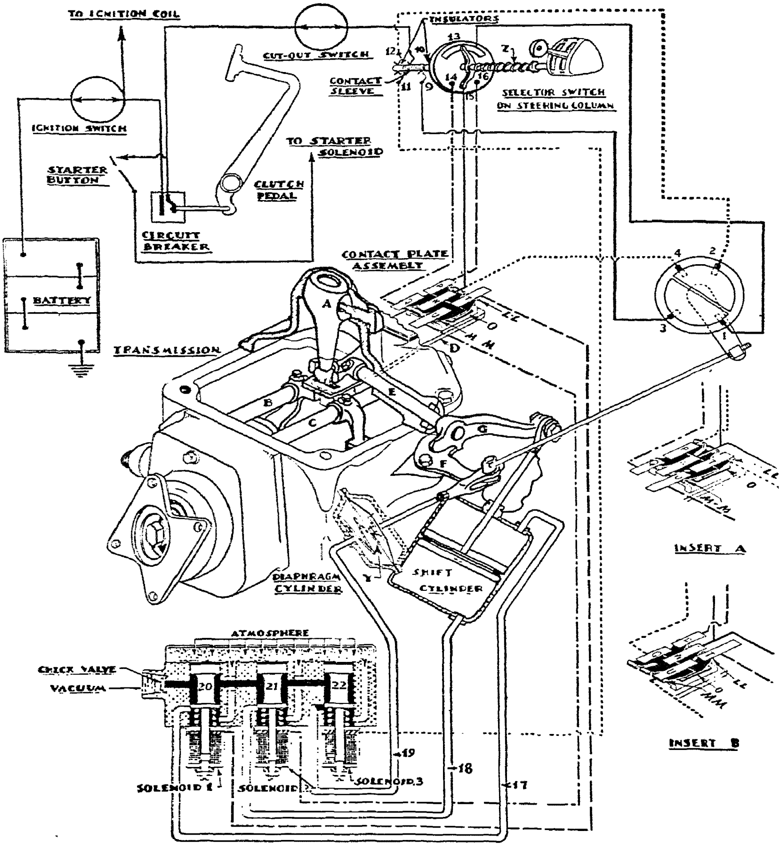


Fig. 47. Diagram of New Hudson-Bendix Electro-Vacuum Shift with Selector Switch in Center of Gate

cutting off the atmospheric vent and connecting the engine vacuum around the reduced diameter of the plunger, to the diaphragm cylinder. When the solenoid No. 3 is not energized, the spring *Y* holds the shifting lever *A*, Fig. 47, engaged with the high and second shift rail. When solenoid No. 3 is energized, the vacuum draws the diaphragm backward, holding the shift lever *A*, Fig. 48, engaged with the low and reverse rail.

The shift cylinder has a vacuum line connected to both the front and rear of the piston. The connection to the front is connected to the valve controlled by solenoid No. 1, and the connection to the rear, to the valve controlled by solenoid No. 2. The linkage between the shift cylinder piston and the lower end of the shift lever *A* requires both to move in the same direction. When solenoid No. 1 is energized, the piston and lever *A* move forward. When solenoid No. 2 is energized, the piston and lever *A* move backward. When neither No. 1 nor No. 2 solenoid is energized, both sides of the shift cylinder are open to the atmosphere, and the piston is at rest.

Solenoid No. 1 is connected to the stationary bar *T* of the contact plate, and will be energized whenever the circuit from the battery is completed to *T*. Likewise, solenoid No. 2 is connected to stationary bar *U* of the contact plate, and will be energized by completing the battery circuit to *U*. The sliding contacts *LL* and *MM* are insulated from each other as well as from their mounting, and are moved forward or backward with the transmission lever movement, through the connecting bar *D*. Sidewise movement of the shifting lever *A* does not affect the position of the sliding contacts *LL* and *MM*.

The circuit from the battery to *T* can be completed through the three fingers of sliding contact *LL*, from either the stationary bar *W* or *P;* while the circuit from the battery can be completed to bar *U* through the three fingers of sliding contact *MM*, from stationary bars *Q* or *W*. The connection from solenoid No. 3 is direct to contact *11* on the shaft of the selector switch. Thus we see that where the circuit is completed from the battery to *T*, the shifting rail movement will be forward; when the circuit is completed from the battery to *U*, the shifting rail movement will be to the rear; when the circuit to *11* is open, the shifting lever *A* will be pressed toward the notch in the high and second shifting rail *B;* and when the circuit *11* is closed, the

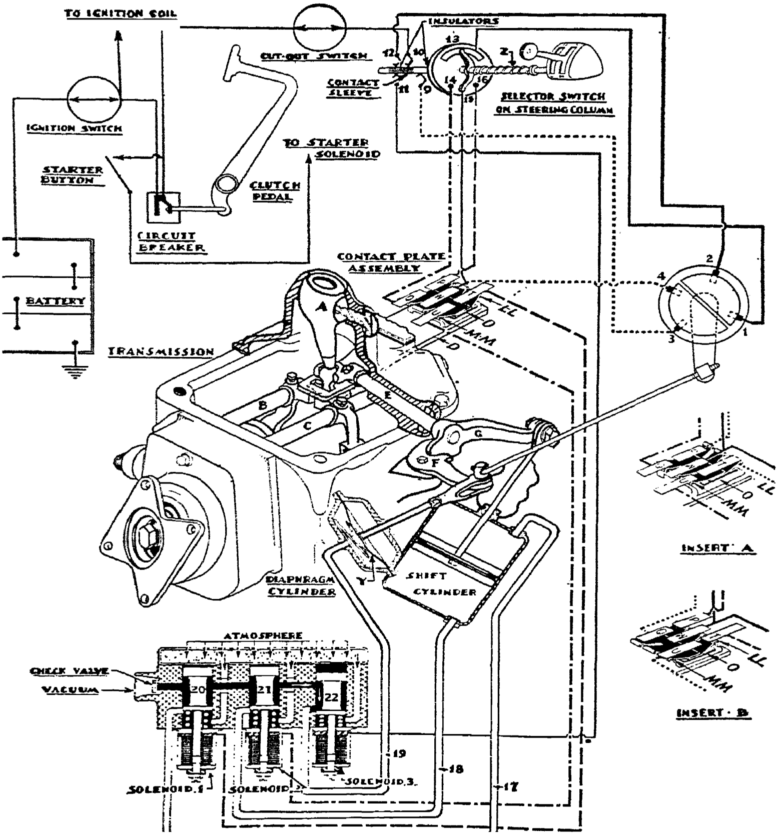


Fig. 48. Diagram of New Hudson-Bendix Electro-Vacuum Shift with Selector Switch in Neutral

shifting lever *A* will be drawn toward the low and reverse shifting rail *C*.

The selector switch, in conjunction with the contact plate and the interlock switch, Fig. 46, controls the circuits to these points. The selector switch, Fig. 47, has five positions arranged in the form of the letter "H." The cross bar represents the neutral position, while the four ends of the uprights of the "H" correspond to the four gear positions of the transmission and are arranged in the same order as the positions of the conventional transmission shifting lever.

In Fig. 47, the selector switch is shown in its normal neutral position. The spring *Z* holds the shaft and the lever to the right end of the cross bar of the "H" in line with the high and second gear positions. Note that this corresponds to the normal position of the shifting lever *A*, which is held in proper engagement for a direct shift into high or second by the spring *Y* of the diaphragm cylinder. It is, therefore, unnecessary to provide a contact for *11* for shifting to high or second gear, as no cross shift is required and *11* rests on an insulated sleeve on the selector switch shaft. If, however, the control lever is pushed to the left of the cross bar, in line with low and reverse positions, it is necessary to have a cross shift to engage the low and reverse shifting rail. The contact sleeve on the selector switch shaft is moved to the left by the left movement of the control lever, so that it is contacted by *11*. The rotating motion of the selector switch lever rotates a contact bar which is always in contact with sector *13*, and also contacts *14* when the lever is in reverse or second, *15* when in neutral, and *16* when in high or low.

The means of shifting the transmission and a switch for selecting the gear required, the actual circuits for obtaining the desired movements for a given position of the transmission and selector switch, are discussed below.

The circuit from the battery leads to the ignition switch to the circuit breaker on the clutch pedal (circuit closed with clutch depressed), the cut-off switch on the selector switch housing to contact *10* which is at all times in contact with the sleeve on the shaft of the selector switch. With the selector switch in the normal neutral position, and the transmission in neutral, as shown in Fig. 47, the circuit from *10* is completed to *9* to *3* and *1* on the interlock switch, to *13* and *15* on the selector rotary switch, to contact bar *W*. (Circuit shown in solid lines.) With the transmission in neutral, neither *LL* nor *MM* contact *W*, so that the circuit is broken at this point and no movement of the shift rails is obtained.

If, however, the transmission were in high gear, the shifting lever *A* would be forward, holding *LL* and *MM* forward as shown in insert *A*, Fig. 47. This would bring the middle finger of *MM* in contact with *W*, closing the circuit to *U* and solenoid No. 2, and the shifting lever *A* would be moved backward to neutral, at which point contact would be broken as in the main diagram of Fig. 47, and movement would cease. With the transmission in second gear, the contacts *LL* and *MM* would be moved backward (insert *B*, Fig. 47) and contact would be made from *W* to *LL* to solenoid No. 1, and the shifting lever would move forward to neutral, breaking the contact.

It is readily seen that moving the selector switch down into high gear position would not affect the circuit except from *13* to *16*, which would connect (circuit in broken line) to *P* through *LL* to solenoid No. 1, and shift rail *B* would be moved forward from neutral, engaging high gear. As the shifting lever and rail moved forward, *LL* and *MM* would also move forward, and the contact between *P* and *LL* would be broken, as shown in insert *A*. Note that contact is made from *P* to *LL* to *T* with the contact plate either in neutral or the backward position; and the shift would be made to high gear if the transmission were in either second or neutral when the selector switch was moved to high gear position.

Now, moving the selector switch over to the second gear position, completes the circuit (dash dot lines) from *13* to *14* to *Q* through *MM* to solenoid No. 2, moving the shift rail *B* backward from neutral to second gear position, at which point the contact between *Q* and *MM* is broken (insert *B*, Fig. 47). Note that contact is completed from *Q* to *MM* to *U* both with the contact block in neutral and the forward position, so that the shift would have been made to second gear if the transmission were in either high or neutral when the selector switch was moved to the second gear position.

Fig. 48 shows the selector switch in neutral, but moved to the left of the cross bar of the "H" and the transmission in neutral. With the left movement of the selector switch lever, the contact sleeve has also moved to the left, breaking contact with *9* and contacting *11* and *12*. (Completed circuits shown in solid lines.) Solenoid No. 3, having been energized from contact *11*, has moved the shifting lever into contact with the fork of shifting rail *C*, so that forward and backward movement will now engage low or reverse gears. Note also that the interlock switch has been turned by the backward movement of the diaphragm. The circuit from *12* is to *2-1* on the interlock switch, to *13* to *15* to *W*. This duplicates the condition in Fig. 47, so that the transmission will be returned to neutral from either low or reverse. Turning the selector to contact *14* now corresponds to reverse, and *16* to low gear, and forward or backward movement of the shifting lever will engage and disengage low and reverse in the same manner that high and second were controlled in Fig. 47. (Circuit for low shown in broken lines, circuit for reverse in dot and dash.)

Fig. 49 shows the transmission in low gear and the selector switch in high. The shifting lever is held to the right, as the spring *Y* cannot force it to the left until the shifting rail has moved to neutral, and the interlock switch is still held in the low and reverse position as in Fig. 48. When the clutch pedal is depressed, the circuit (solid lines) is closed through *10-9* to *3-4*, on the interlock switch to *W*. As shown previously, a completed circuit to *W* caused the transmission to move to neutral. In this instance the controlling circuit (solid lines) is from *W* through *MM* to *U* to solenoid No. 2, and the first part of the shift will be from low to neutral.

As soon as the shifting lever *A* reaches the neutral position, the spring *Y* forces it to the left to engage in rail *B*. This cross movement also turns the interlock switch back to the high and second position, as shown in the insert, so that the circuit from *9* is changed (changed circuit shown in broken lines) to *3-1* on the interlock switch to *13*, and with the selector switch set for high gear, to *16* to *P* through *LL* to *T* and a normal shift from neutral to high is made. Had the selector switch been set in second gear, the connections would be the same until neutral is reached, when the circuit will be completed (circuit in dot and dash) from *13* to *14* to *Q* through *MM* to *U*, causing a normal neutral to second shift.

Fig. 50 shows the transmission in high gear and the selector switch set for low. The interlock switch is in the high and second position. When the clutch pedal is depressed (completed circuits in

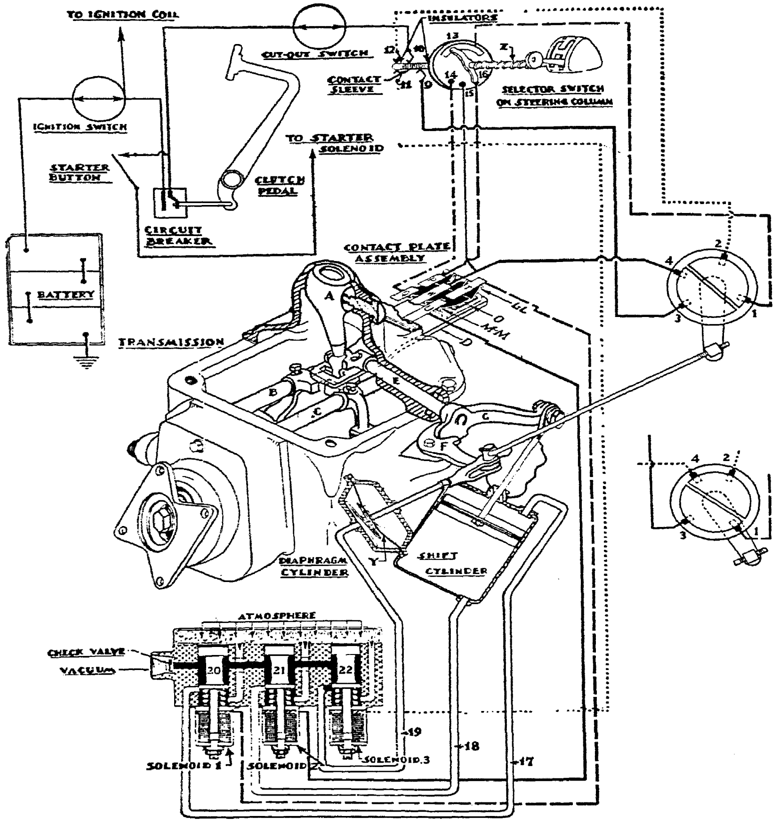


Fig. 49. Diagram of New Hudson-Bendix Electro-Vacuum Shift with Selector Switch in High Gear

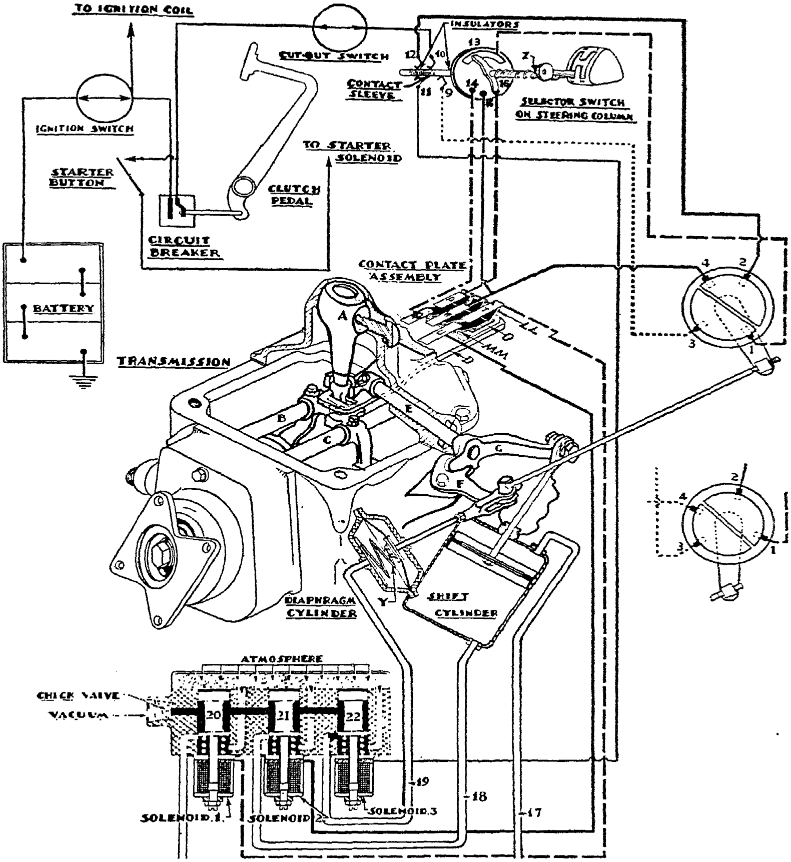


Fig. 50. Diagram of New Hudson-Bendix Electro-Vacuum Shift with Selector Switch in Low

solid lines) the circuit is completed from *10* to both *11* and *12*. The circuit from *11* energizes solenoid No. 3, but since the shifting lever *A* cannot move to the right until the shift rail *B* reaches the neutral position, no movement is caused and the interlock switch remains in the high and second positions.

The circuit from *12* is completed to *2-4* on the interlock switch, to contact bar *W* through *MM* to *U*, causing the shift rail *B* to be moved backward to neutral. Here the movement is arrested by breaking contact between *W* and *MM*, and the vacuum acting on the diaphragm causes the shift lever *A* to move to the right, rotating the interlock switch to the low and reverse position. The circuit from *12* has now been changed as shown in the insert and is completed (circuit in broken line) through *2-1* of the interlock switch to *13* to *16* to *P* through *LL* to *T*, causing a normal neutral to low shift. Had the selector switch been set to reverse, connecting *13* and *14*, the circuit (circuit in dot and dash) would then have been completed to *Q* through *MM* to *U*, causing a normal neutral to reverse shift.

It will be seen that the interlock switch has no function so long as the selector switch and the gear shift lever are set so that a straight forward or backward movement of the shift lever *A* is required; however, if a cross movement of the shifting lever *A* is required to complete the desired shift, it requires the transmission to come to neutral and will not permit any further movement of the shifting rails until the cross movement is completed.

As a safety factor, the circuit breaker makes it impossible to make a shift until the clutch has been disengaged. Due to the fact that the selector switch lever can be moved to any position after the engine has been stopped, without a shift being made, it is impossible to tell by the position of the selector switch lever, whether or not the car is in gear when the engine is dead. To prevent starting the engine with the car in gear, a circuit breaker on the clutch pedal requires disengagement of clutch, before starter switch circuit is complete.

MECHANICAL ADJUSTMENT

Adjustment of Cross Shift Stop Screws. Shift transmission into high gear, Fig. 46. Back off stop screw *K* until it does not touch the stop. Turn the stop screw *K* in, until it just touches stop, then turn in an additional ¼ turn and tighten lock nut. After this adjustment is made, a .004-inch feeler should just pass between the outside face of the lug on lever *G*, and the outside finger of bell crank *F*. Shift the transmission into low gear, using the power unit. Back off stop screw *M* until it does not touch the stop. Turn the stop screw *M* in, until it just touches the stop, then turn an additional ¼ turn and tighten the lock nut. After this adjustment is made, a .004-inch feeler should just pass between the inner face of the lug on lever *G*, and the inner finger of bell crank *F*.

Adjustment of Length of Diaphragm Cylinder Shaft. Remove the clevis pin from the diaphragm cylinder rod clevis, Fig. 46. Loosen lock nut *X*. With the bell crank lever *F* pushed forward so that the stop screw *K* is against its stop, turn the clevis until the clevis pin hole is ¼-inch ahead of the hole in the lever, when the diaphragm cylinder rod is in its extreme forward position. Tighten lock nut *X*. Push diaphragm cylinder rod back to align holes, and replace the clevis pins.

Adjustment of Interlock Switch. Shift the transmission into low gear and then into high gear. The pointer on the interlock switch lever should register with the line on the interlock switch cover. If not, adjust as follows. Loosen the front stop; then turn the rear stop until alignment is obtained while interlock switch lever is held back against rear stop. Then tighten the front stop. Shift the transmission into low gear, then to high, and recheck to see that the pointer registers with the line on the interlock switch cover.

Adjustment of Power Cylinder Piston Rod. Shift the transmission into high gear. Remove the clevis pin *N* from the lever *G*, Fig. 46. Push the rubber piston-rod guard back and loosen the lock nut on the piston rod. Turn the rod end until the clevis pin *N* can be reinserted with the piston rod pulled to its extreme forward position. Push the piston rod back and lengthen four threads by turning the clevis. Tighten the lock nut. Reinsert the clevis pin *N*.

Adjustment of Clutch Circuit Breaker. With the clutch fully engaged, the pointer on the lever should be in line with the arrow on the top of the circuit breaker housing. To adjust, when equipped with automatic clutch control, loosen the clamp bolt nut on the bracket mounted on the vacuum clutch rod, and slide the clip until the pointer is in line with the arrow. Tighten the lock nut. When not equipped with automatic clutch control, remove the cotter key from the circuit breaker lever pin. Loosen the lock nut on the operating rod and remove the rod end from the lever pin. Turn the rod end until it will slip on the pin, with pointer in line with the arrow on the housing. Insert cotter pin and tighten the lock nut.

The position of the circuit breaker lever is important. If the contact is made with too little clutch pedal movement, the clutch will still be engaged when the shift is made, and if a gear has been pre-selected, the shift will be made while the engine is driving the car. If the contact is made with too much pedal movement, the shift will not be completed should the gears butt teeth. It is necessary to have a slight clutch drag before the circuit is broken, to turn the gears and insure engagement. It may be necessary, therefore, to set the circuit breaker slightly ahead of the indicating arrow.

SERVICE OPERATIONS

Preliminary Service Check. The following are to be checked before attempting to make any repairs to the gear-shift control mechanism, regardless of the nature of the failure. Be sure the cut-out switch on the selector housing is "on." Be sure that the transmission is free and can be moved into all its positions manually with clutch pedal depressed just enough to close the circuit through the clutch circuit breaker. (Check by pressing the starter button.) Adjust the interlock straps on the transmission if necessary. If temperatures are encountered low enough to cause the recommended transmission lubricant to retard the gear shifting excessively, replace 3 ounces of the lubricant with kerosene. Inspect the vacuum line and fittings. Check wire connections on the interlock switch. Make certain that all clevis pins and cotter pins are in place. Inspect junction block on power unit to see that all six wires are in place. Make certain that all soldered connections are intact in both portions of steering column jack. (To remove covers, twist, with jack assembled.) Check the wiring harness for breaks or damaged insulation.

Quick Test for Short Circuit. With the instrument panel lamp lighted, shift into all positions with the "electric hand." Any appreciable dimming of the instrument lamp indicates a short circuit.

Gears Are Shifted with Clutch Engaged. Probably there is a short circuit in the clutch circuit breaker, or improper position of the circuit-breaker arm. Check, and if necessary, adjust the clutch circuit breaker. Turn on the ignition switch and press the starter button; if the starter operates with the clutch fully engaged, replace the circuit breaker.

Complete Failure of "Electric Hand" to Function. After setting the pointer and arrow on the circuit breaker in line, turn on the ignition switch, depress the clutch pedal and press the starter button. If the starter functions, circuit is closed through the circuit breaker. If the starter does not function, attach grounded test lamp to the yellow wire terminal of the circuit breaker. No light, indicates an open circuit from ignition switch to circuit breaker. A light, indicates the circuit breaker circuit open. Replace circuit breaker.

Failure of "Electric Hand" to Function in Any or All Positions. If a proper circuit is proven through the circuit breaker and operation is still faulty, disconnect the separable jack on the bottom of the steering column and insert the jack from a master selector switch and wire assembly. (This unit does not require any ground.) If the system functions properly when using this selector switch instead of the one mounted on the car, replace the complete selector switch and wire assembly. This includes all parts on the steering column, including the upper part of the separable jack. See note below if master selector lamp lights. Do not replace selector until the short circuit is removed.

Testing the Shifting Mechanism. Connect the power unit test cable to the terminal on the clutch circuit breaker to which the red wire is attached. This wire should be "hot" only when the clutch is disengaged. With the engine running and the clutch disengaged (rear wheels of car jacked up) touch the front post *YB* of the junction block on the shifting unit with the test prod. The transmission should shift into high gear. Touch the rear post *Y* and the transmission should shift to second gear. Shift the transmission to neutral manually. First touch the center post *W* with the test prod, and the cross shift should be made. Still contacting *W*, touch the front post *YB* with the second test prod. The transmission should shift into low. Touch the rear post *Y*, still contacting *W*, and the shift should be made to reverse. If a shift is not made when one of the posts is contacted, connect an accurate ammeter to the hot wire and to the terminal. A current draw of approximately 2.5 amperes indicates that the solenoid is O.K. A higher amperage indicates a short, and a low amperage an open circuit. **Caution:** A dead short circuit in a solenoid will burn out the ammeter if permanent connection is made.

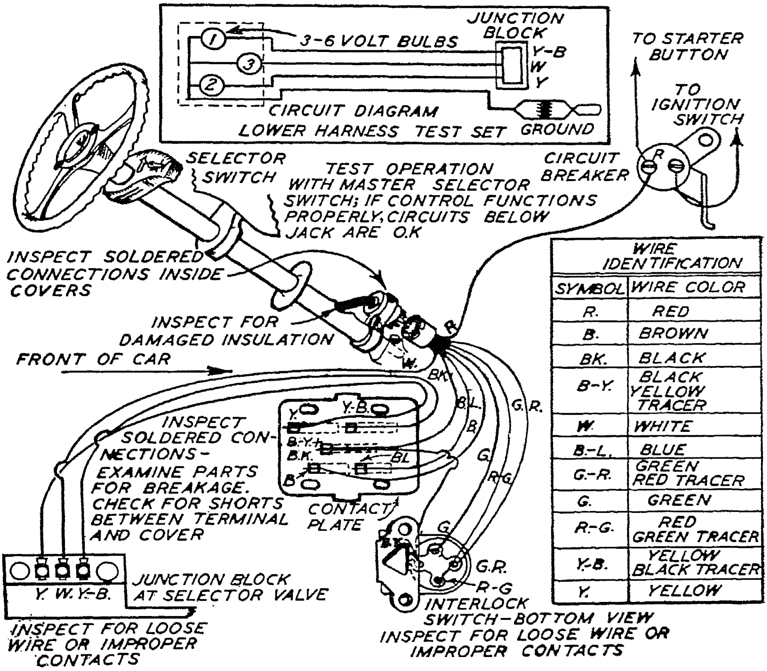
If the current draw is correct, the trouble may be due to the valve plunger sticking in its upward position, a vacuum leakage in the lines or units, or a mechanical drag in the mechanism. Disconnect the shifting cylinder piston rod from the shifting lever, or the diaphragm cylinder from the cross shift bell crank. If these do not function after disconnecting the linkage, the entire power unit should be replaced.

Testing Circuits in Lower Harness and Switches. If only partial functioning or complete failure is experienced after the master selector has been plugged in, test the complete circuits at the solenoid junction block with the lower harness test lamp set. (This test must be performed with a selector switch known to be O.K.) Remove the three wires on the end of the wiring harness from the junction block on the selector valve. Insert these three wires into the jack fitting on the lower harness test set, in correct position according to color. Attach ground clip to a clean metal ground on car. Turn the ignition switch on, turn cut-out switch on and hold clutch fully disengaged. Place the selector lever in neutral. Place the transmission in neutral manually. When the shift lever is moved a short distance toward second, test lamp *YB* should light. When shift lever is moved a short distance toward high, test lamp *Y* should light. With the transmission in neutral, move the selector lever to low. Test lamp *W* only, must light. Transmission remains in neutral. When selector lever is moved into second position, test lamp *Y* should light. When selector lever is moved into high position, test lamp *YB* should light. When selector lever is in low and in reverse, lamp *W* should light.

As the transmission is shifted manually to correspond to any position chosen at the selector switch, the proper lamps, as indicated above, should remain lighted during the shift. However, lamp *Y* or *YB*, whichever is lighted, should go out when the shift is completed. Lamp *W* alone, will remain lighted in low or reverse position.

If, in any of the above tests, the correct lamps do not light or additional lamps are lighted, replace 47327 switch and wire assembly.

Test to detect improper contact plate adjustment. If, after a new lower harness assembly has been installed, either lamp *Y* or *YB* remains on when the transmission is in neutral in test above, the contact plate is incorrectly adjusted. To adjust contact plate, loosen the four screws holding the contact plate assembly, then see if the plate is free to move back and forth through movement permitted by elongated holes. If not, remove the plate from the transmission cover, and carefully cut off or remove locating dowel pins. Replace the contact plate as nearly as possible in its original position, and partially tighten the four screws so that the plate may be moved to its proper position.


JUNCTION BLOCK
3-6 VOLT BULBS
1
3
2
Y-B
W
Y
CIRCUIT DIAGRAM
LOWER HARNESS TEST SET
GROUND
TO STARTER BUTTON
TO IGNITION SWITCH
R
SELECTOR SWITCH
TEST OPERATION WITH MASTER SELECTOR SWITCH; IF CONTROL FUNCTIONS PROPERLY, CIRCUITS BELOW JACK ARE O.K
CIRCUIT BREAKER
INSPECT SOLDERED CONNECTIONS INSIDE COVERS
INSPECT FOR DAMAGED INSULATION
FRONT OF CAR
W.
BK
BL
B
G
R.G
G.R.
INSPECT SOLDERED CONNECTIONS - EXAMINE PARTS FOR BREAKAGE. CHECK FOR SHORTS BETWEEN TERMINAL AND COVER
Y
Y-B.
B-Y.
B.K.
BL
B
CONTACT PLATE
G
G.R.
R-G
BK
Y. W. Y-B.
JUNCTION BLOCK AT SELECTOR VALVE
INSPECT FOR LOOSE WIRE OR IMPROPER CONTACTS
INTERLOCK SWITCH-BOTTOM VIEW
INSPECT FOR LOOSE WIRE OR IMPROPER CONTACTS

WIRE IDENTIFICATION	
SYMBOL	WIRE COLOR
R.	RED
B.	BROWN
BK.	BLACK
B-Y.	BLACK YELLOW TRACER
W.	WHITE
B-L.	BLUE
G.-R.	GREEN RED TRACER
G.	GREEN
R.-G.	RED GREEN TRACER
Y.-B.	YELLOW BLACK TRACER
Y.	YELLOW

Fig. 51. Hudson "Electric Hand" Wiring Diagram

If test lamp *YB* remains lighted when the transmission is in neutral, move the plate very slightly to the rear until lamp *YB* goes out. (If lamp *Y* remains lighted, move the block forward.) The proper setting is obtained when the movement of the shift lever forward from neutral, necessary to bring lamp *YB* on, is equal to the backward movement required to bring lamp *Y* on.

To Check Position of Interlock Switch. Place the transmission in low gear and the selector switch in high gear, and depress the clutch. Lamp *Y* should light and remain lighted until the transmission is shifted (manually) to neutral. Lamp *YB* should be lighted when the cross shift to second and high side is completed. If lamp *YB* is lighted before the cross shift is practically completed, the interlock switch is not in proper position, and should be adjusted so that the pointer on its lever is in line with the mark on the housing when the transmission is in high gear. If adjustment does not give proper operation, replace the interlock switch. If the above tests show that some circuits are not correct, replace the wire and switch assembly (lower harness with interlock switch and contact plate).

FAILURES RESULTING FROM FAULTY CIRCUITS

See wiring diagram, Fig. 51. A faulty selector switch may cause any of the failures listed below. A master selector switch should be used when checking the control. If control operates perfectly with master selector switch, an investigation of the other units is necessary.

Transmission fails to move into:	Faulty circuit through (See note)	Transmission fails to move out of:
Any position	Red wire	Any position
Any position	Green wire with red tracer	Any position—except that transmission may be brought to neutral by moving selector switch to opposite side of gate.*
Low* Reverse	White wire or Green wire**	
Low High	Blue wire	
Neutral—except when selector switch is moved to opposite side of gate***	Black wire	

Second Reverse	Brown wire	
Second Reverse	Yellow wire	Low High
Low High	Yellow wire with Black tracer	Second Reverse
Second High	Red wire Green tracer	
Certain positions unless started manually	Transmission contact plate assembly. Surface of contact bars must be carefully cleaned	Certain position unless started manually.
Transmission fails to follow a fast or preselective shift from a position on one side of gate to a position on the other side (from low to second, or from high to low, for example)	Black wire with Yellow tracer	Transmission will follow when selector switch is moved very slowly

Note: Faulty circuit may be caused by either a short or an open circuit. In most cases, failure will be due to an open circuit, but when a short is encountered, master selector switch fuse will blow. When this occurs, lamp adjacent to the fuse should burn at full brilliance. (A 6–8-volt, 32-CP single-contact bulb must be used. Allow master switch to remain in position which caused fuse to blow, i.e., in a position in which the bulb burns at full brilliance.) Then check faulty circuit for a short. When the short is located and eliminated, bulb will burn at approximately half brilliance—which is normal. After short has been eliminated, insert new 7½-ampere fuse and check operation of control in all positions.

(*) If green wire with red tracer is damaged, transmission will not move out of neutral position into any other position, but if it is placed in high position manually, it may be brought to neutral by moving selector lever into low. If placed in low position manually, it may be brought to neutral by placing selector lever in high.

(**) If green wire is damaged, shift lever will still move back and forth with selector lever as the latter is moved from left to right. If white wire is damaged, shift lever will remain on the second and high side, even though selector lever is moved back and forth from right to left.

(***) If black wire is damaged, it is impossible to place transmission in neutral by merely moving selector lever to neutral. However, if transmission is in either second or high position, it may be placed in neutral by moving selector lever to neutral and then as far to the left as possible. Transmission may be moved into and out of every position, except neutral, in the normal manner.

CAR OVERDRIVE

The overdrive gear set is usually attached to the transmission. It is designed to operate automatically above a predetermined car speed. It may be used in second speed, provided the second gear car speed is high enough to cause the clutch pawls (worked by centrifugal action) to engage, although it is designed primarily for high gear operation. One car maker has a rear axle with a gear ratio giving 60 miles per hour at 3,200 revolutions per minute of the engine. When in overdrive, the engine slows to 2,000 revolutions per minute at 60 miles per hour. The ratio of the overdrive is 1.6 to one.

When desiring to engage the automatic overdrive, the first step is to set the dash control unit in position for free wheeling at low speeds (below critical predetermined speed) and this same setting gives fixed drive in overdrive. The car speed will be picked up in free-wheeling conventional gear to the automatic overdrive cut-in speed and then the driver releases the accelerator pedal, allowing the engine speed to drop down to the proper engine speed for the car speed. At this point the overdrive engages automatically, and serves to drive the car or compression-brake the car. After the car speed drops to about 10 miles below the overdrive engagement speed, the overdrive is automatically disengaged. The driver quickly learns to accommodate his driving habits to the overdrive. In overdrive, the engine noises are quieted and the car operation is smooth.

Studebaker Overdrive. The purpose of the overdrive is to reduce the engine revolutions at the higher car speeds. This results not only in increased engine efficiency throughout the entire speed range, but also in an unusually quiet high-speed operation. Engine wear is, of course, also reduced at the higher car speeds. The overdrive, Fig. 52, is combined with the free-wheeling unit, and is located to the rear of, and integral with, the transmission. Its operation is automatic, functioning at speeds about 57 miles per hour.

The free-wheeling unit, although combined with the overdrive, functions in the usual manner. It is effective, however, only up to a car speed of 57 miles per hour, at which point the overdrive functions and locks out the free wheeling. With the free-wheeling button on the instrument board pulled out, the free-wheeling and overdrive shaft is shifted to its rearmost position. This engages the splines of

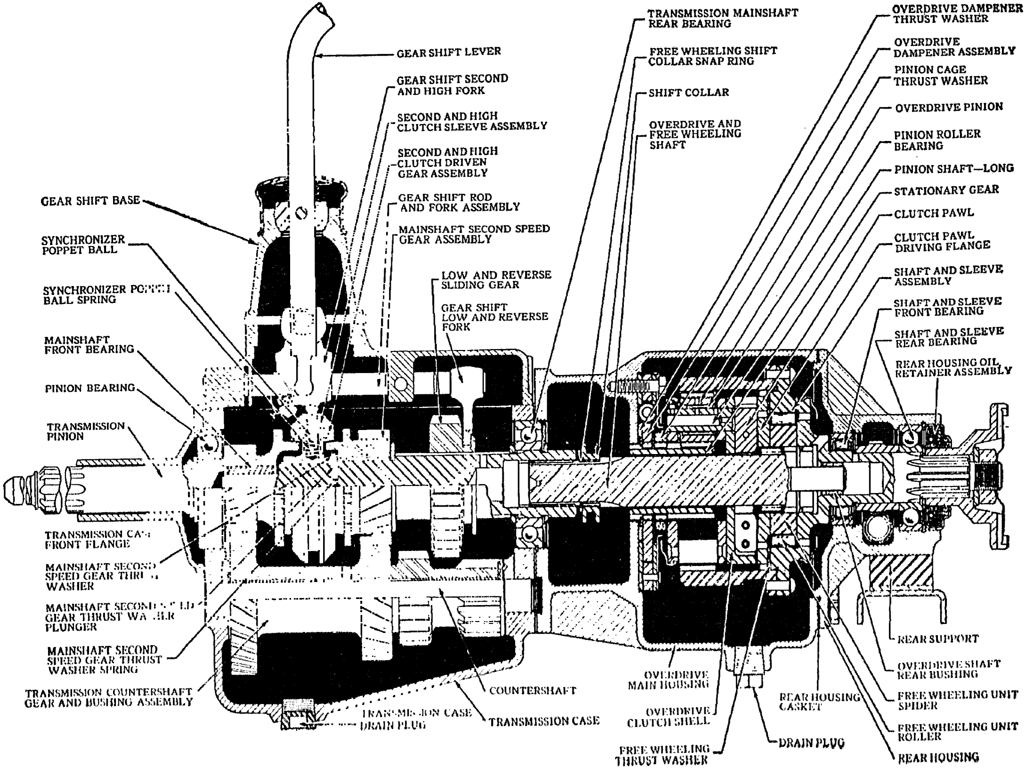

GEAR SHIFT LEVER
GEAR SHIFT SECOND AND HIGH FORK
SECOND AND HIGH CLUTCH SLEEVE ASSEMBLY
SECOND AND HIGH CLUTCH DRIVEN GEAR ASSEMBLY
GEAR SHIFT ROD AND FORK ASSEMBLY
MAINSHAFT SECOND SPEED GEAR ASSEMBLY
LOW AND REVERSE SLIDING GEAR
GEAR SHIFT LOW AND REVERSE FORK
TRANSMISSION MAINSHAFT REAR BEARING
FREE WHEELING SHIFT COLLAR SNAP RING
SHIFT COLLAR
OVERDRIVE AND FREE WHEELING SHAFT
OVERDRIVE DAMPENER THRUST WASHER
OVERDRIVE DAMPENER ASSEMBLY
PINION CAGE THRUST WASHER
OVERDRIVE PINION
PINION ROLLER BEARING
PINION SHAFT—LONG
STATIONARY GEAR
CLUTCH PAWL
CLUTCH PAWL DRIVING FLANGE
SHAFT AND SLEEVE ASSEMBLY
SHAFT AND SLEEVE FRONT BEARING
SHAFT AND SLEEVE REAR BEARING
REAR HOUSING OIL RETAINER ASSEMBLY
GEAR SHIFT BASE
SYNCHRONIZER POPPET BALL
SYNCHRONIZER POPPET BALL SPRING
MAINSHAFT FRONT BEARING
PINION BEARING
TRANSMISSION PINION
TRANSMISSION CASE FRONT FLANGE
MAINSHAFT SECOND SPEED GEAR THRUST WASHER
MAINSHAFT SECOND SPEED GEAR THRUST WASHER PLUNGER
MAINSHAFT SECOND SPEED GEAR THRUST WASHER SPRING
TRANSMISSION COUNTERSHAFT GEAR AND BUSHING ASSEMBLY
TRANSMISSION CASE DRAIN PLUG
COUNTERSHAFT
TRANSMISSION CASE
OVERDRIVE MAIN HOUSING
OVERDRIVE CLUTCH SHELL
FREE WHEELING THRUST WASHER
REAR HOUSING GASKET
DRAIN PLUG
REAR SUPPORT
OVERDRIVE SHAFT REAR BUSHING
FREE WHEELING UNIT SPIDER
FREE WHEELING UNIT ROLLER
REAR HOUSING

Fig. 52. Sectional View of Transmission and Overdrive Assembly—"President"
Courtesy of Studebaker Corporation of America

the free-wheeling unit spider and the overdrive shaft and sleeve assembly, locking them together and providing a direct drive through the assembly to the propeller shaft at all speeds.

With the free-wheeling button pushed in, the free-wheeling and overdrive shaft is shifted to its forward position. This engages the splines of the free-wheeling unit spider and the overdrive clutch pawl driving flange. With the engine pulling the car, at speeds below 57 miles per hour, the drive is then through the free-wheeling unit spider, the free-wheeling unit rollers, and the overdrive shaft and sleeve assembly to the propeller shaft. Free wheeling, therefore, is available up to a car speed of 57 miles per hour.

With the free-wheeling button pushed in for free-wheeling operation and the car speed increased to more than 57 miles per hour, the drive is through the overdrive mechanism. Centrifugally operated clutch pawls move out and engage and drive the overdrive clutch shell. The drive is transmitted from the shell to the overdrive pinion gear cluster, through three of the overdrive pinion gear shafts which extend into the forward face of the clutch shell. The five needle-bearing-mounted overdrive gears, making up the pinion gear cluster, rotate around a stationary gear (overdrive stationary gear) and in the internal teeth in the overdrive shaft and sleeve assembly. The pinion gears, rolling on the stationary gear, in addition to rotating as an assembly, necessarily drive the overdrive shaft and sleeve assembly at an increased speed. The ratio of the overdrive and free-wheeling shaft to the overdrive shaft and sleeve assembly, is one revolution of the overdrive and free-wheeling shaft to 1.418 revolutions of the overdrive shaft and sleeve assembly.

It is obvious that, in overdrive, the difference in the speeds of rotation of the overdrive-free-wheeling shaft and the overdrive-sleeve assembly shaft must be absorbed through the free-wheeling unit; therefore, the overdrive is not available in conventional gear position. In conventional gear position, the splined rear end of the overdrive-free-wheeling shaft does not engage the overdrive clutch pawl driving flange, and thus permits the flange to float.

A pin attached to the overdrive and free-wheeling shifter fork, extends into the transmission proper in such a manner that the shifting of low and reverse sliding gear into reverse, also shifts overdrive and free-wheeling shaft back into the conventional gear position.

REAR AXLES

Final Drive. Ordinarily the term, final drive, is used in connection with the rear system inasmuch as it receives the power which is developed by the engine, passed through the transmission, through the universal joints and propeller shaft to the rear axle where it is sent through the two axle shafts to the rear wheels.

Passenger car rear axles are largely standardized. In the early days of the development of the automobile, many forms of drive were utilized and served a purpose in the development of the present type of rear axle. Some of the very earliest forms made use of the V-belt, others made use of chains and in quite a number of the early models a transmission similar to our present day sliding transmission was carried on the rear axle housing just ahead of the differential case.

Fig. 1 illustrates an Oldsmobile chassis in plan view. Power from the engine is passed through the clutch to the transmission and from that point it is passed into the forward universal joint to the exposed propeller shaft, to the rear universal joint and from that point into the pinion shaft, thence to the ring gear and from it to the spider and thence to the side gears and finally through the axle shafts to the two rear wheels. The line of flow of power is thus relatively simple.

At this point it is well to recognize briefly other types of final drive which have had more or less prominence and continue to be given consideration. One of these is the front drive, and the other is the rear engine rear drive car which has met with success in foreign countries and is receiving consideration generally by automotive engineers.

The reader should distinguish at this point between the two terms, final drive and car drive. Final drive refers to the method of transmitting the power from the engine and transmission through the rear axle to the road wheels, while car drive refers to the method of applying the power developed

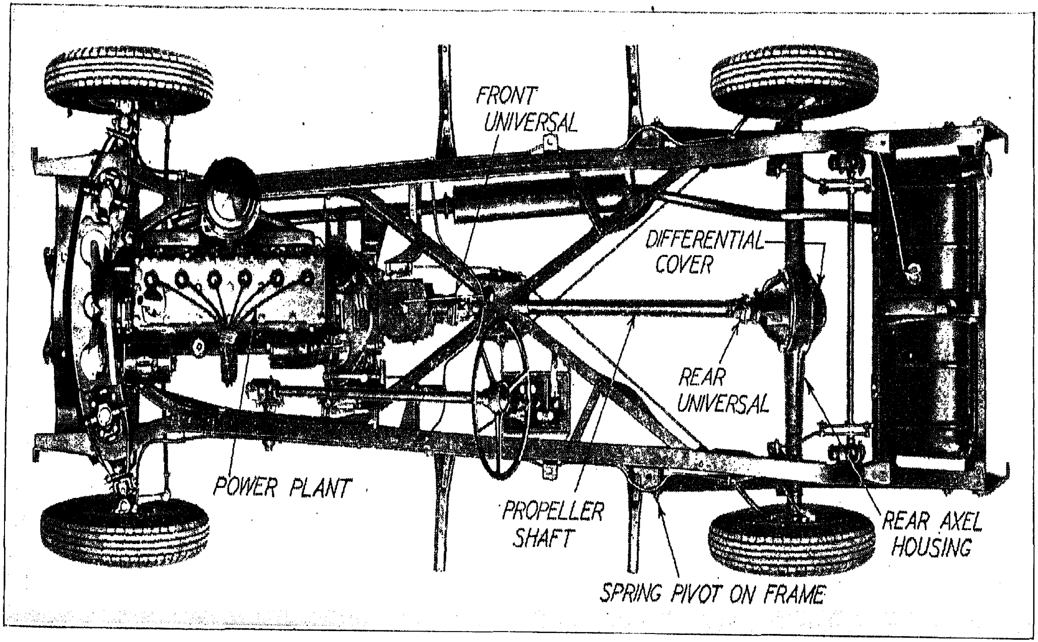


Fig. 1. Layout of Units in Final Drive of Oldsmobile Chassis

by the tractive effort of the rear wheels on the roadway, back to the car in order to propel the car forward.

Rear Axle Unit. Fig. 2 shows a rear axle of conventional design fitted into a type of frame which is termed a banjo frame. This type of rear axle housing is also termed a banjo housing. Fig. 3 illustrates a phantom view of a full floating type of rear axle. This axle utilizes the popular banjo type housing, with the spring perches on the top of the housing.

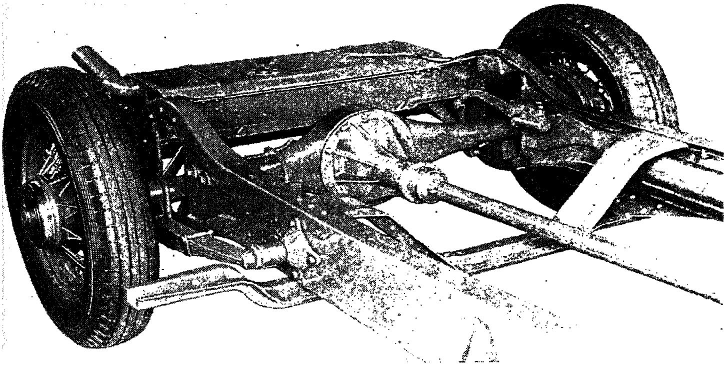


Fig. 2. Banjo Type Rear Axle Mounted in Banjo Type Frame (Graham)

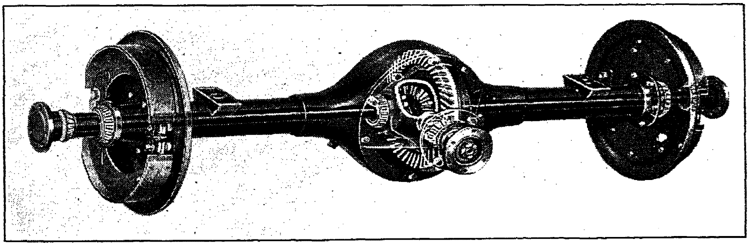


Fig. 3. Full Floating Rear Axle with Banjo Housing

The rear axle illustrated in Fig. 4 is similar to that in Fig. 3 except that the type of axle is known as semi-floating. Note also that the spring pads are facing downwards as this axle is designed to carry the springs with underslung suspension, rubber blocks being mounted on the top of the axle for unusual road impact.

Bevel Drive. The most usual form of drive for rear axles is the bevel drive illustrated in Fig. 5. Here it will be noted that a pinion gear shaft is connected to the universal joint flange *A*, being supported in two taper roller bearings, the pinion gear meshing with the ring gear which is carried on the differential. Formerly many axles were made with a straight tooth bevel, but the spiral bevel illustrated in Fig. 5 was adopted because of quietness in operation and long life. Mounted centrally in the differential carrier which is used to mount the ring gear externally are what is known as side gears and spider gears. These serve to give the differential

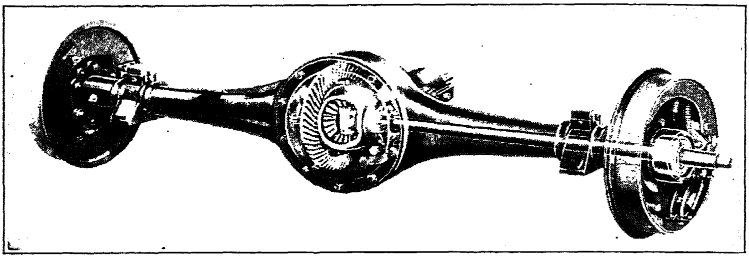


Fig. 4. Semi-Floating Rear Axle with Banjo Housing

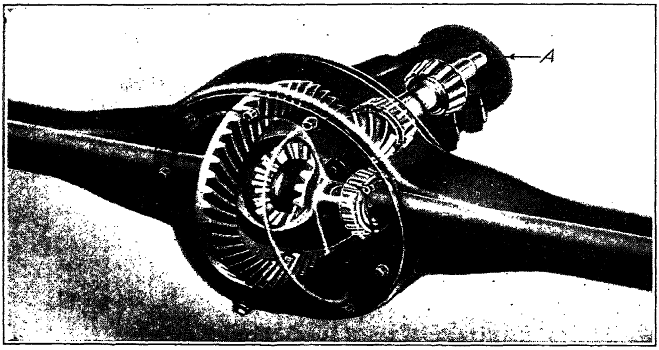


Fig. 5. Ring and Pinion Gear Assembly

action required in all rear axles to allow one wheel to drive ahead of the other when rounding turns.

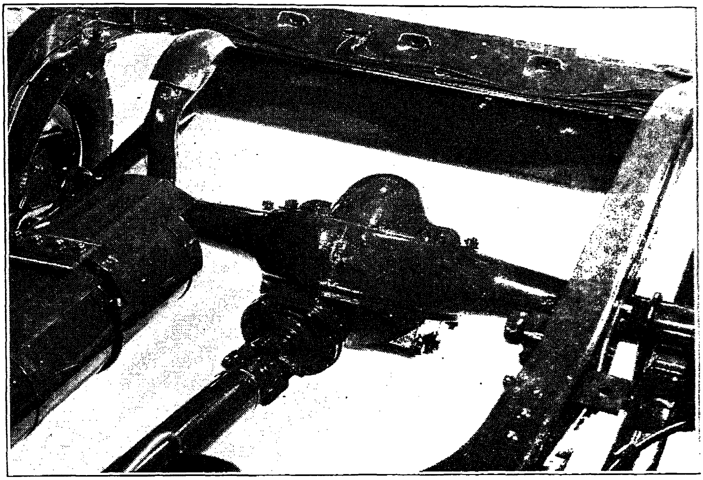


Fig. 6. Packard Rear Axle

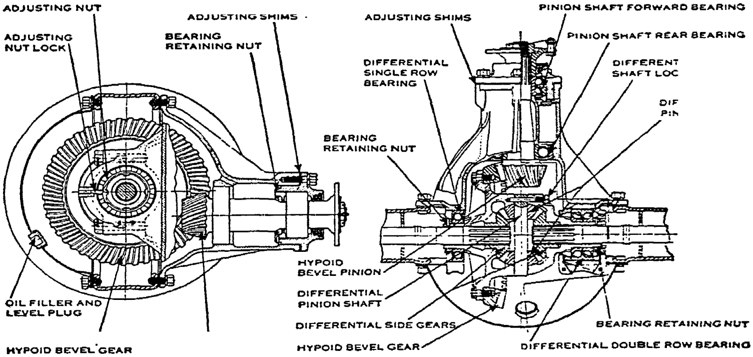


Fig. 7. Hypoid Bevel Gears with Names of Related Parts

Hypoid Gears. Fig. 6 illustrates a Packard automobile rear axle and frame assembly with the banjo housing set on an angle. This is done in order to accommodate the hypoid type of gearing being used. The main point of difference between the hypoid gear and the conventional spiral bevel gear is the fact that the center line of the pinion gear shaft is dropped below the center line of the axle shafts which are naturally in line with the center line of the ring gear. Figs. 7 and 63 illustrate views of these gears.

Worm Drive. The worm drive is illustrated in Fig. 8 which shows an axle housing in phantom view and the worm gear and

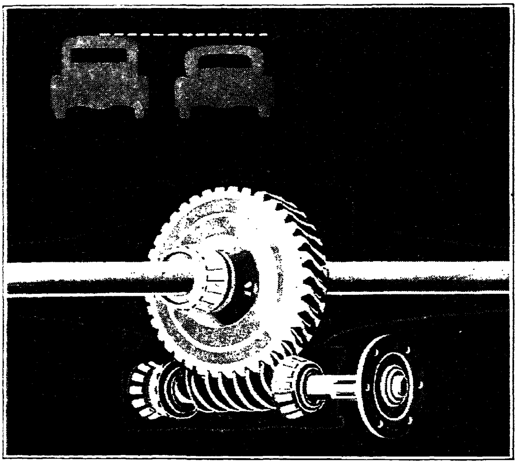


Fig. 8. Worm Drive for Rear Axle

worm in bold relief. It will be noted that the worm is beneath the worm gear, having at its forward end a flange which is turned by the universal and propeller shaft. Placed in this position the worm is always surrounded by lubricant and this of course is dipped by the worm gear as it is turned. One advantage of the worm gear is its long life and quiet operation. Another one, which is rather marked, is best illustrated by the phantom views of the two cars at the top, Fig 8, which shows one considerably lower than the other. This design is made possible because of the fact that with the worm drive and carrying the propeller shaft low, it is possible to lower the seats in the car body, consequently lowering the overall car body height.

Banjo Housing. The banjo housing, Fig. 2, is usually formed from several stampings welded along the center line. The structure is strong as well as being relatively light. When repairing the gears or differential of the banjo type housing, it is necessary to remove the cover plate or inspection plate from the rear of the housing and also to unbolt and loosen the differential carrier from the forward part of the housing. When these two parts are stripped off, the part remaining has much the appearance of a banjo, consequently its name. It will be seen that this type of housing has the ability to carry weight. It is not necessary, as stated above, to remove the rear axle housing from the automobile in order to make repairs on the gears.

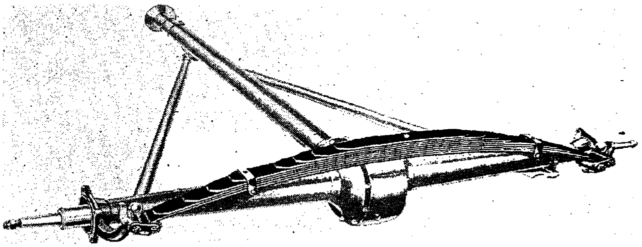


Fig. 9. Ford V-8 Torque Tube Drive Rear Axle Fitted with Transverse Spring

Split Type Axle Housing. An outstanding example of the split type axle housing is illustrated in the case of the Ford V-8 in Fig. 9. This axle housing is of three-piece construction, excluding of course the torque tube. All parts are of steel and welded construction. The central unit has bolted to it the two side housings. These in turn have bolted to them on their outer ends, the dust shield and brake backing plates, not shown in this illustration. When repairs are necessary to the gears or axle shafts in an axle of this type, it is necessary to remove the axle from the car, giving support to the car while the work is being done. The Ford "A" axle assembly in sectioned view is shown in Fig. 10. This axle is quite similar to the Ford V-8 axle.

Ring Gears. The spiral bevel gear illustrated in Fig. 11 is ordinarily spoken of as the ring gear. The gear which meshes with this gear is called the pinion gear. Sometimes the pinion shaft *A*, Fig. 5, and the pinion gear are made of one piece. In other cases the gear is made separate, Fig. 12, and fitted to the shaft on a taper, being locked thereto by means of a key and nut.

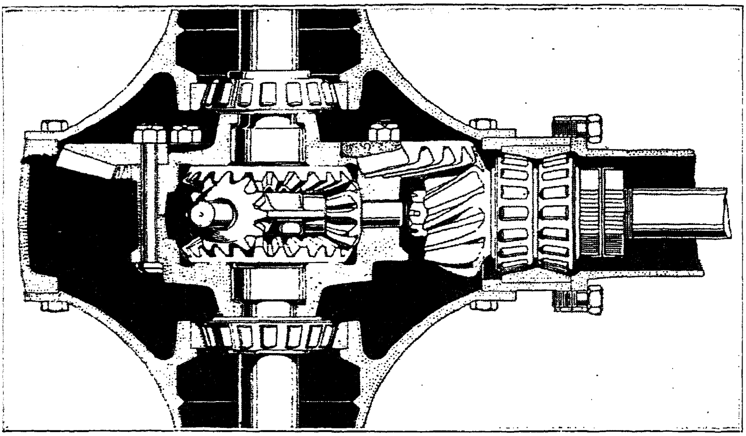


Fig. 10. Ford Model "A" Final Drive, Differential, and Axle Shafts

The ratio of the rear axle is determined by the number of teeth in the ring gear when compared with the number of teeth in the pinion gear. For instance, if there are fifty teeth in the ring gear and ten teeth in the pinion, then the ratio is 5 to 1; that is five turns of the engine in high speed on the transmission are required to turn the rear axle shafts once.

Spider Gears. The gears illustrated in Fig. 13 are termed spider gears. These are mounted on a cross or through bolt which is termed the spider. Sometimes there are three of these gears, sometimes two and in many cases four. Studying Fig.

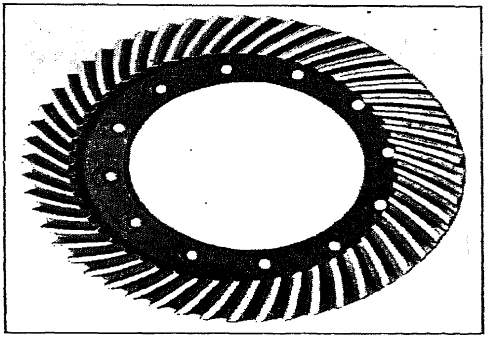


Fig. 11. A Ring Gear

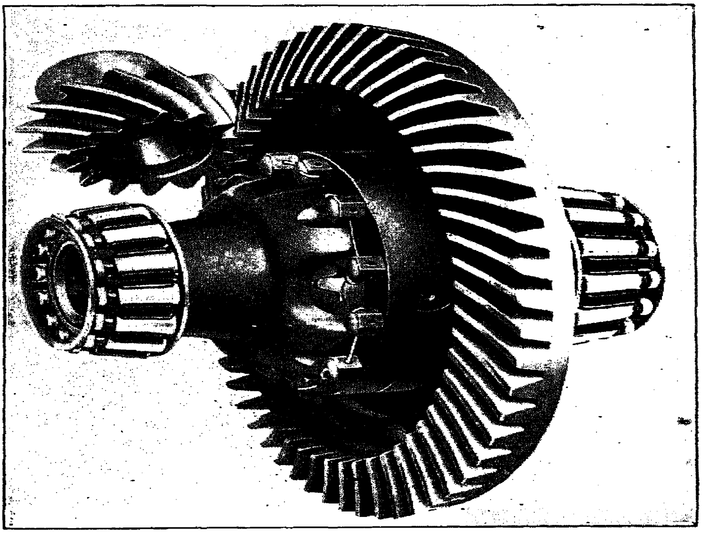


Fig. 12. Spiral Bevel Gears

13 it will be noted that the outer surfaces of these gears, where they are fitted to the spider, are rounded in form. This permits them to fit into the differential case snugly. The spider is turned by the differential case as it in turn is rotated by the action of the ring gear in mesh with the pinion gear. Turning the spider has the effect of causing the spider gears on it to rotate with the spider and, in case the car is being driven straight ahead, the spider gears on the spider will remain stationary except for their forward rotative motion as a unit.

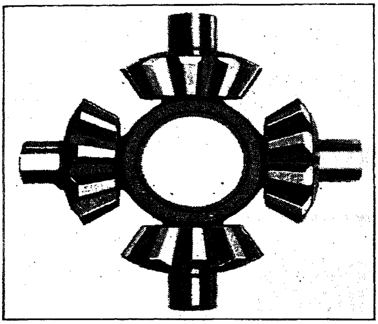


Fig. 13. Spider with Spider Gears

In case the car is being driven around a turn, then it is necessary for the wheel on the outside to rotate faster than the wheel on the inside. This action sets up what is termed a differential action, causing the spider pinions on the spider to rotate in one or the other direction, depending upon the turn being made.

Side Gears. The axle gears or side gears as they are commonly termed are illustrated in Fig. 14 showing the spider gears meshed between them. In this instance, a two-gear spider assembly is used. The reader should remember, in studying the action of the differential, that it is the spider gear which first receives the power from the engine and causes it to move round with the differential case. However, it should also be remembered that unless one side gear is slowed down by the natural wheel action when rounding a turn, the spider gear itself does not rotate on its spindle. Looking at Fig. 14, it will be seen that if one of the side gears were to be held and the spider moved around with the differential case, then the other side gear would be caused to rotate more rapidly than it would in normal straight forward drive. Rounding a turn in the opposite direction would cause the other side gear to be driven more rapidly, this differential action being necessary to compensate for the relative distances traveled by the two rear wheels when being driven on a turn.

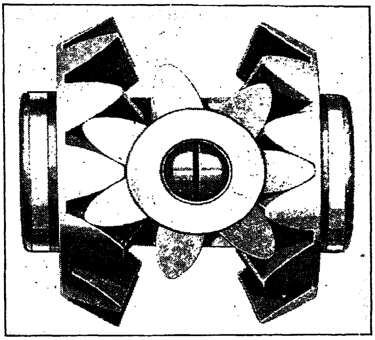


Fig. 14. Spider Gears and Side Gears

Except for the differential action, tire wear would be very rapid and strains upon the axle shafts would be quite severe. Every motorist is familiar with the lack of traction which may arise when one wheel is on the dry roadway and the other one in mud, on a wet roadway, or icy pavement. In attempting to make a start or pull out of hard or difficult going, the wheel with less traction is likely to spin. This is possible because of the differential action which is provided by the spider gears and the side gear set-up.

Racing drivers using fast cars on dirt tracks frequently use what is known as a locked differential. In fact, the differential is done away with and, instead of the side gears, a solid metal block is utilized into which the ends of the axle shafts are set. This prevents spinning of one wheel under heavy load and provides better traction. Racing cars, being driven at speed on dirt tracks, usually have so much power applied to them that the tires tend to slip continually. The fact that the inner wheel must travel a shorter distance than the outer wheel is compensated for by less slippage of the outer wheel than of the inner. Cars thus equipped are more difficult to steer owing to their tendency toward a side thrust of the front end of the car, due to lack of differential action at the rear wheels.

Conventional Axle Design. The sectioned view of the axle, Fig. 15, might be termed approximately conventional. In this

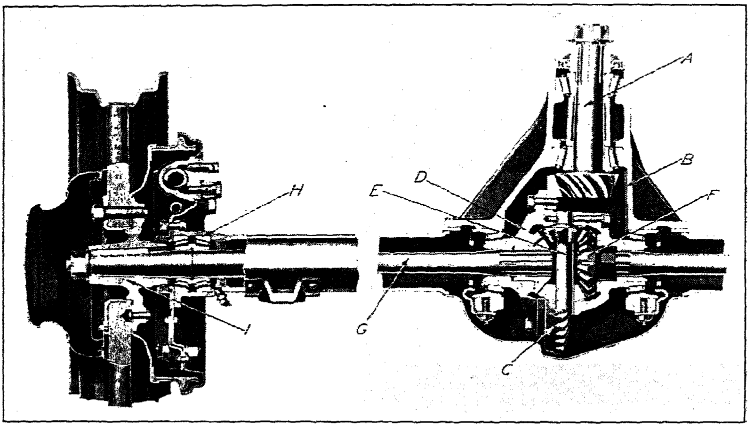


Fig. 15. Sectioned View of Semi-Floating Rear Axle

illustration, the pinion gear and shaft are indicated at *A*, the differential carrier at *B*, the ring gear at *C*, the spider with one spider gear at the upper end at *E*, and the differential case in part section at *D*. The inner ends of the axle shafts *G* are carried in the inner spline of the side gear *F* as shown. The outer end of the axle shaft is tapered to support the wheel hub *I*. The outer end of the axle shaft is supported in the bearing *H*, which in this case is a double tapered roller bearing.

When a double bearing, as indicated at *H*, is utilized, the two bearings serve to take the inward thrust from the road wheels. It also serves to prevent the axle shaft from floating outward. In many designs, the axle shaft is held in by means of a single bearing at this point, and the inner ends of the axle shafts are allowed to butt together with a hardened pin or washer between their inner ends. Thus, the right-hand shaft thrusts against the left-hand shaft and vice versa. Where this design is made use of, it is necessary to have a spider similar to the one illustrated in Fig. 14, allowing the inner ends of the shaft to pass through the spider.

Axle Shafts. There are three distinct types of axles used under this classification—(1) the semi-floating form, carrying the drive and all of the load on the axle, the axle shafts not being removable without removing the wheels; (2) the three-quarter floating form, carrying the drive and a small part of the load, the latter being divided between the shaft and its housing, but with the shafts removable; seven-eighths floating form, carrying the drive but not the load, the arrangement of bearings to take the load being such that the wheel hubs do not rest wholly and solely upon the axle-housing end; and (3) the full floating form, in which the shaft does nothing but drive, and is removable at will without disturbing the wheel and wheel weight resting on the axle-housing end, which is prolonged for this purpose.

With the full floating form, any accident to the wheel, in which it was struck from the side, also damaged the housing, or tube, end. The result of this in nine cases out of ten was to make the removal of the wheel impossible, because the tube end, which projected through, was bent over. Moreover, repairing in such a situation called for a new axle housing—a very expensive proposition. Consequently, the seven-eighths floating form was developed to present all the advantages of the full floating form, with this serious drawback eliminated by a rearrangement of the parts which did not necessitate prolonging the axle through the wheel hubs. However, it did not gain favor as rapidly as the other floating forms, and now is almost out of use.

The three diagrams in Fig. 16 explain the axle types as well as words can. At the top is shown the full floating axle, perhaps the most expensive form. In the middle, the semi-floating axle, which makes the axle shaft do all the work—carrying load as well as transmitting power—is shown. At the bottom is the three-quarter floating form, which is really a combination of the other two forms and possesses a maximum of advantages with a minimum cost. The car weight is carried on the tubing, while the shaft drives and carries a portion of the side stresses to which the wheels are subjected, the quantity depending upon the construction of the bearings.

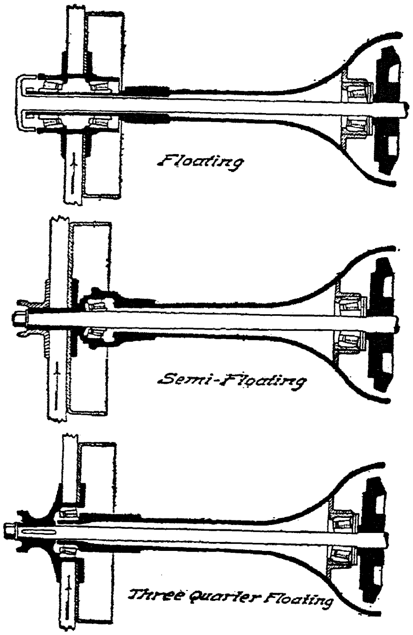


Fig. 16. Arrangement of Axle Bearings and Housing in Three Principal Forms of Rear Axle

Fig. 3 shows a full floating axle, with the ends of the driving shafts projecting beyond the housing and carrying five jaws which mesh with five similar ones in the wheel hubs and thus drive the wheels.

Wheel Attachments in Full, Three-Quarter, and Semi-Floating Types. Apart from the difference in design between the three types of axles, there is a difference in the attachments of the wheels to the axles and the manner in which the wheel is driven by the axle. In the full floating type there are slots cut in the hub of the wheel, and on the axle is a flange in which is cut or machined projections or dogs which fit tightly into the slots cut into the hub. In this manner the wheel is driven, the shaft being held in place by the hub cap and a spring. Fig. 17 shows the construction of the outer end of the axle with the bearings in place and the axle can be removed without disturbing the wheel. The hub cap is already removed in the view shown.

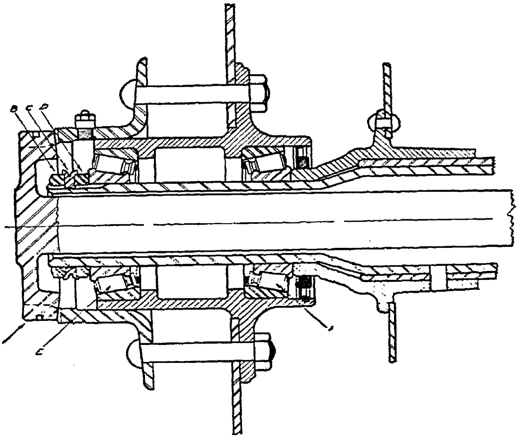


Fig. 17. Wheel Attachment Full Floating Axle

In the three-quarter floating type, Fig. 18, the axle is attached to the hub flange by a taper on the axle and a nut. The flange is held to the wheel hub by bolts upon which are acorn nuts. To remove the axle it is only necessary to remove the acorn nuts, the wheel and the hub flange clamping nuts. The advantage of the two foregoing installations is that adjustments can be made to the wheel bearings at the end of the axle without disturbing the wheels.

In the semi-floating type, Fig. 19, the wheel is attached to the axle by taper, key, and nut, as in the three-quarter type, but before any adjustment can be made to the bearings, the wheels must be taken off the axle. In this type of drive, the axle and wheels must be removed before the differential unit can be removed, while in some three-quarter and full floating, the axle can be removed and the differential taken out and the car allowed to stand on the wheels, which is safer and much easier for the repair man. It is quite an asset to the repair man to be able to recognize on sight the three types of axles. If he is able to do this, he will know how to start to do any repair work without waste of time. The full floating is recognized by the shape of the hub after the hub cap is removed and by the

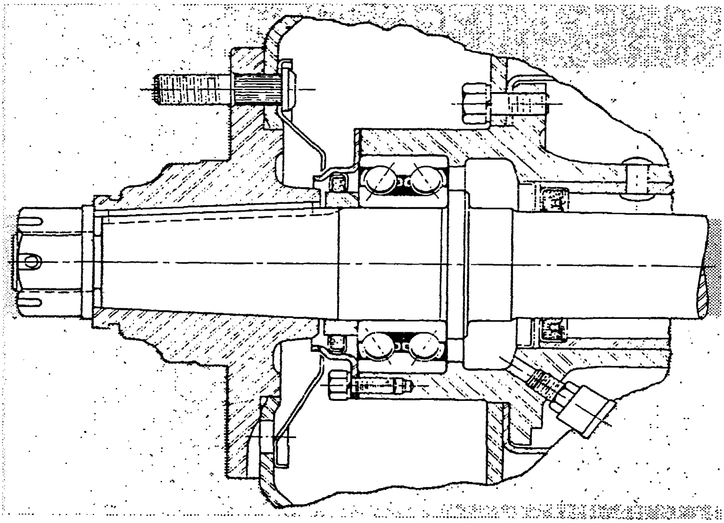


Fig. 18. Wheel Attachment Three-Quarter-Floating Axle
Courtesy of The New Departure Manufacturing Company

slots. The three-quarter is recognized by the nut on the outside of the wheel hub. The semi-floating is recognized by the absence of the nuts on the outside of the wheel hub or by the shape of the hub after the cap has been removed, and by the absence of the slots.

Hotchkiss Drive. The worm view of the rear axle suspension, shown in Fig. 20, gives the student a very good idea of what is ordinarily termed Hotchkiss drive. Here it will be noted that the axle housing is bolted to two semi-elliptic springs, the forward end of these springs being secured in a bracket which in turn is mounted to the side frame of the car. As the rear wheels are turned and the car is pushed forward, the actual driving or pushing of the car in a forward direction is effected through the main leaves of the semi-elliptic springs. Note that the rear end of the springs are shackles to permit elongation when the spring is under load. In the Hotchkiss

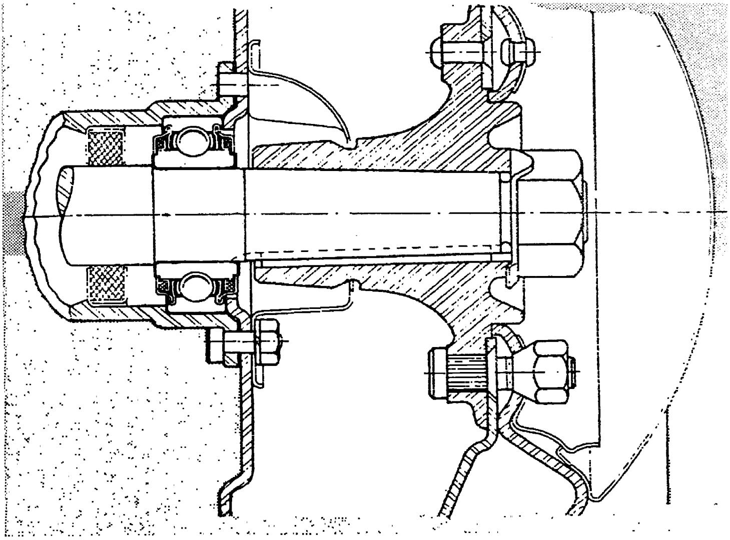


Fig. 19. Wheel Attachment Semi-Floating Axle
Courtesy of The New Departure Manufacturing Company

drive the alignment of the rear axle housing with the car frame is secured solely and wholly through the spring assembly.

The Hotchkiss drive makes use of an exposed propeller shaft as illustrated in Fig. 1, and also in Fig. 20. Note that the rear of the propeller shaft is attached to the forward end of the pinion shaft by means of a universal joint. The universal joint action permits of considerable movement of the rear axle housing without any bad effects from misalignment of the rear axle with reference to the propeller shaft, this being the very purpose for which the universal joint is incorporated. Naturally there is a certain elongation of the distance between the pinion gear shaft and the rear of the transmission. For this reason it is necessary to incorporate some form of sliding joint in one or the other of the universal joints. Ordinarily this is placed in the forward universal joint.

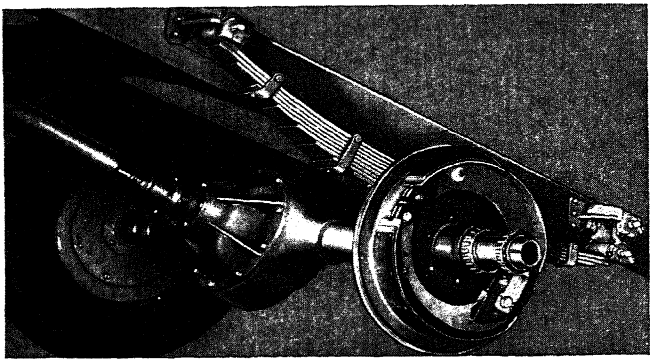


Fig. 20. Worm Drive View of Hotchkiss Drive

Torque Tube Drive. The torque tube drive which is utilized in the case of the Buick, Ford, and certain other automobiles is illustrated in the case of the Buick automobile in Fig. 21. In this case it will be noted that a rigid tube is bolted securely to the forward end of the differential carrier. This in turn being mounted rigidly to the banjo housing of the rear axle. A study of the Ford assembly in Fig. 9 and again of the

Buick in Fig. 21, shows that radius rods are utilized to keep the torque tube in proper alignment with the rear axle housing, this being adjustable by means of lock nuts.

Where the torque tube drive is utilized, the drive of the automobile is not through the springs but through the torque tube which is provided with a ball type joint where it engages with the rear end of the transmission housing. As the wheels are rotated, the axle is pushed ahead, pushing the torque tube forward and it, in turn, being engaged snugly with the ball joint at the rear of the transmission, forces the transmission and engine ahead, with the result that the engine being bolted rigidly into the car frame takes this thrust and transmits it to the car frame. The reader will grasp that the chief difference in the drive is the fact that the drive comes on to the car frame at the forward end where the torque tube drive is used and back of the middle section where the Hotchkiss drive is used. Each type of drive has its own adherents and each has been found perfectly satisfactory in use on millions of cars. Some companies adhere to one form and some to another.

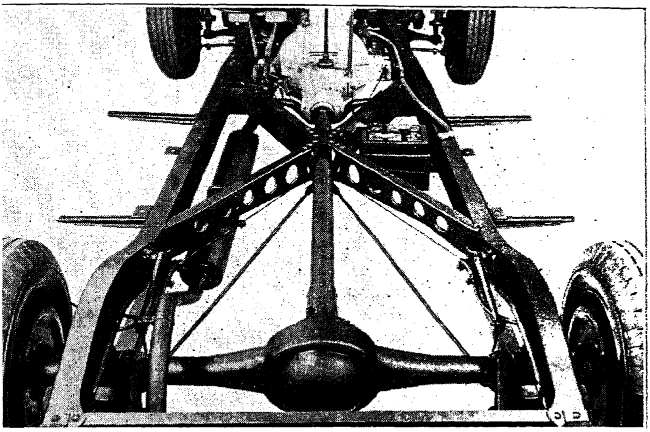


Fig. 21. Buick Rear Axle with Torque Tube Power Drive

In the case of the torque tube drive the propeller shaft is fitted with but one universal joint, this being at the forward end of the propeller shaft and enclosed within the propeller tube or torque tube. In this case again it is necessary to provide for some slight elongation of the distance between the pinion gear shaft and the transmission shaft, and for this reason a slip joint is also provided in this particular drive.

The forward end of the rear springs as well as the rear end of the rear springs are shackled so as to allow free movement. If this were not true, undue strains would be set up on the springs and torque tube. In some cases where the torque tube drive is utilized, the forward end of the torque tube is attached through a ball and socket joint to a cross member, this cross member taking the thrust rather than the rear of the transmission, so that the engine does not have this force to transmit to the car frame.

Torque Reaction. Torque is nothing more nor less than turning effort. Torque reaction then is the resistance to the turning effort. If the reader were to grasp a broom handle in his right hand, it would be relatively easy to turn it. If the left hand were used to resist the turning effort, the energy required to turn it would be increased. With one hand utilized to turn the broom handle, the other hand is then used to resist the torque created. The reaction against the turning effort of the right hand causes the wrist and arm of the left hand to be turned or tend to turn.

Every reader has seen the front end of the car tend to roll sidewise as the engine is rapidly accelerated. With the car standing still this motion is particularly noticeable. The torque or turning effort developed within the engine is the thing which causes it to tend to rotate and the reaction to this torque is evidenced in the twisting of the frame. Much the same sort of thing is evident in the rear axle suspension system. Fig. 22 has been introduced to illustrate this feature so that the reader may have an understanding of what happens in the rear system when power is applied and why either the Hotchkiss drive or the torque tube drive is utilized and the work done by these units. The Hotchkiss type of drive, as shown, illustrates the strain set up in the springs when the power is applied. The tendency of the rear axle to rotate under power is shown by

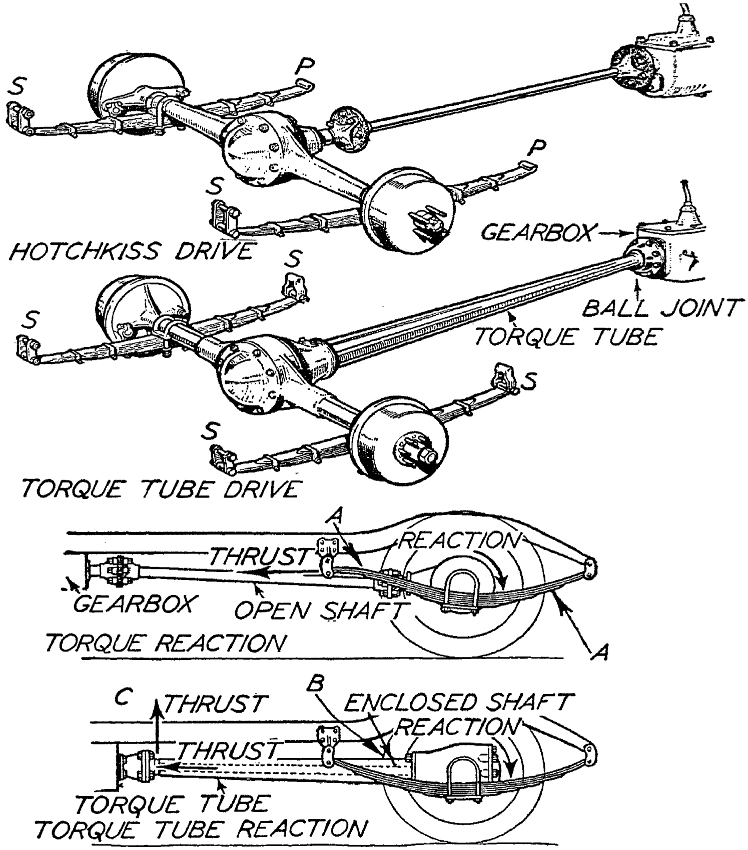


Fig. 22. Hotchkiss and Torque Tube Drives and Their Reactions

the two arrows *A* and *A*. At the same time, the forward thrust of the rear axle and wheel motion is indicated by the arrow as it is transmitted through the top leaf of the spring to the brackets. The reaction set up in the torque tube type of drive is shown where the arrow *C* indicates an upward thrust as the forward thrust is brought on to the axle and torque tube by the power transmitted from the engine. In this case the tendency of the spring to be malformed is not present inasmuch as the axle housing is kept in alignment by the torque tube rather than by the springs.

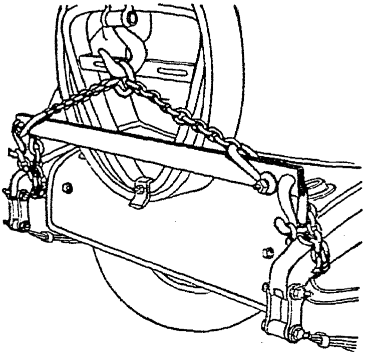


Fig. 23. Car Lifting Device

As mentioned previously, the reader should not confuse in his mind the terms car drive and rear axle drive. The rear axle drive has to do with whether the power is transmitted through chains, belts or gears, while the car drive raises the question whether the Hotchkiss type of drive or torque tube type of drive is utilized. Formerly radius rods were also utilized for car drive. As a matter of fact these are still used in many of the heavier trucks and tractors.

REAR AXLE OVERHAUL—BANJO TYPE

Most passenger-car rear axles are so designed that they may be readily removed from the car. Lift the car with a device similar to that shown in Fig. 23, making use of the one-ton chain block.

The car may be placed on car jacks or blocking, as illustrated in Fig. 24. This will permit freeing the housing and also allow the rear axle to be dropped down and moved rearward from under the car. Modern service stations make use of an

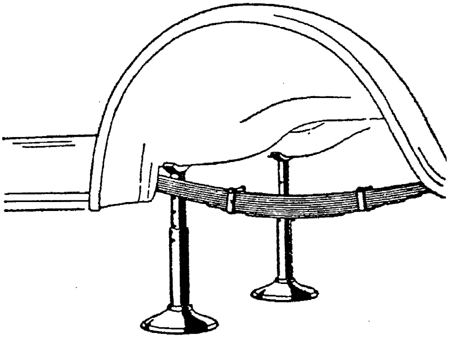
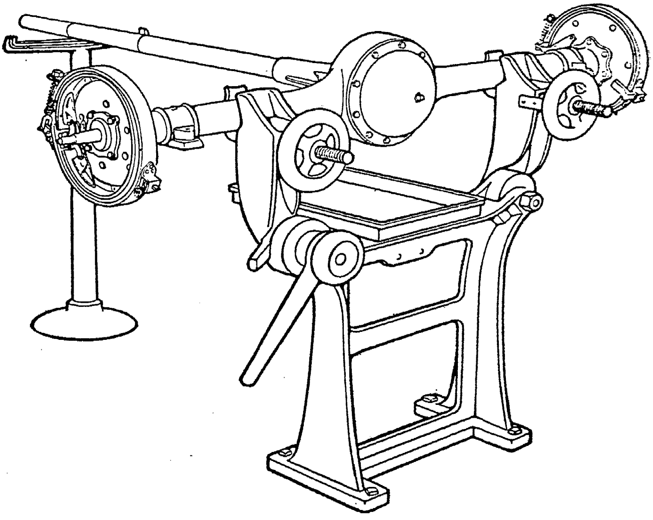


Fig. 24. Blocking Horses or Jacks Support the Car Forward of the Rear Axle, Allowing the Axle to Be Pulled Backward



g. 25. Rear Axle Stand of this Type Speeds Up the Job axle rebuilding stand similar to that shown in Fig. 25. This simplifies all of the repair operation.

Removing Differential Carrier. The differential carrier may be removed, as shown in Fig. 26, for the Chevrolet "Six" by removing the wheels and axle shafts, after which the differential carrier and rear-axle housing screws are removed and the unit pulled off. All work, such as adjusting the pinion and

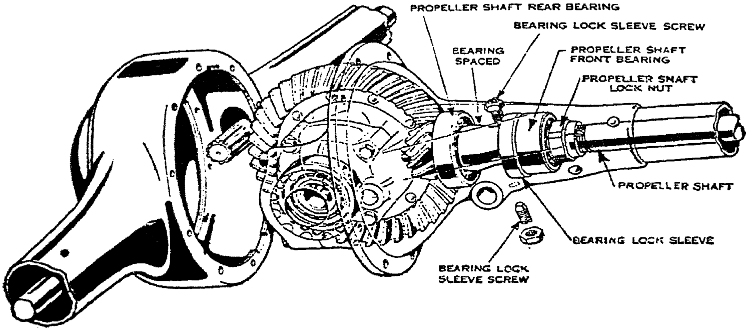

PROPELLER SHAFT REAR BEARING
BEARING LOCK SLEEVE SCREW
BEARING SPACED
PROPELLER SHAFT FRONT BEARING
PROPELLER SHAFT LOCK NUT
PROPELLER SHAFT
BEARING LOCK SLEEVE
BEARING LOCK SLEEVE SCREW

Fig. 26. Removing or Replacing Chevrolet "Six" Rear-Axle Differential Carrier

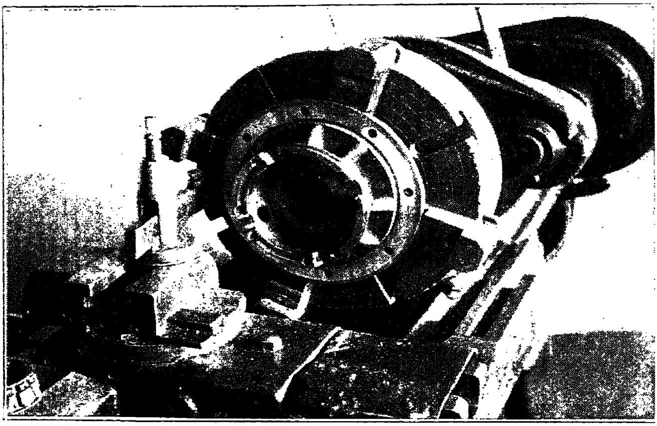


Fig. 27. Facing a Differential Housing

ring gear bearings and the pinion and ring gear mesh as well as the job of replacing the ring gear or pinion gear when such is necessary, is performed with the assembly on the bench.

Perhaps the most usual failure has to do with gear failure. This occurs due to abuse or defective materials or in some cases may be due to foreign objects getting into the rear-axle housing. If any steel passes through between the ring and pinion gear, the differential housing may be sprung, in which case it will need to be replaced or reconditioned on the lathe.

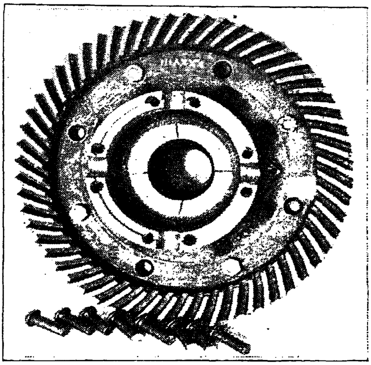


Fig. 28 Preparing a Ring Gear for Riveting

Fig. 27 illustrates a differential housing and ring-gear mounting, mounted in the chuck of a lathe for refacing. It will be noted that the lathe tool is in position for a cut which is almost finished. It will also be noted that a low spot exists between the two rivet holes shown at the upper portion of the differential housing where it is gripped by the chuck jaw. Unless these inequalities are removed, it is impossible to reassemble the housing and ring gear and have the assembly run true.

Riveting Ring Gears. When preparing to rivet ring gears, first install four bolts as shown in Fig. 28. Next proceed to rivet the ring gear to the differential housing as shown in Fig. 29. Cold riveting is preferable to hot riveting. When hot rivets are used, it is impossible to fill the rivet hole completely since

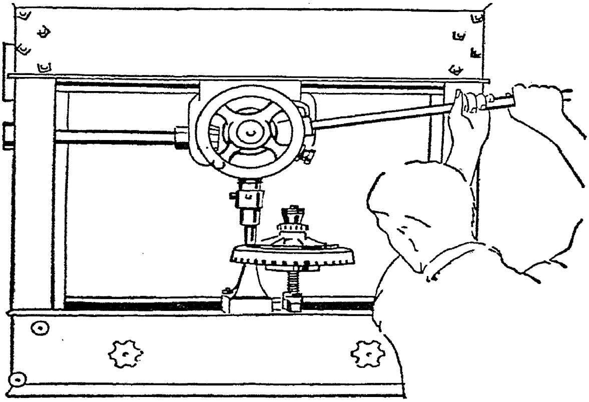


Fig. 29. Riveting a Ring Gear with a Riveting Jig on the Garage Press

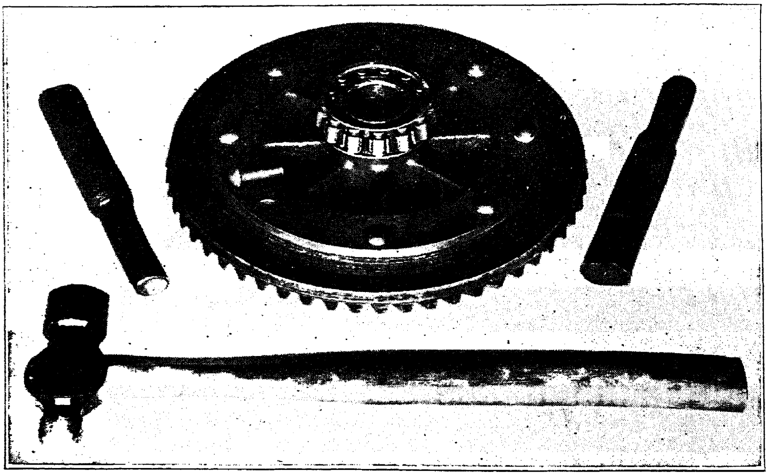


Fig. 30. Tools and Ring Gear Riveting Job

the hot metal will contract as it cools and pull away from the wall of the rivet hole. Fig. 30 illustrates a good job of riveting. This job was performed by means of the hand tools shown. The rivet sets illustrated were made from the old axle drive shafts of a Model "T" Ford car. The cupped ends are just large enough to take the head or bur of the rivet. When riveting a ring gear by the hand method, Fig. 31, support one rivet set in the vise and have a helper hold the work and drive the rivets home with a heavy hammer, as shown in the second rivet set. When using an arbor press and riveting attachment as shown in Fig. 29, be very careful to keep the parts in alignment. This will insure a good job.

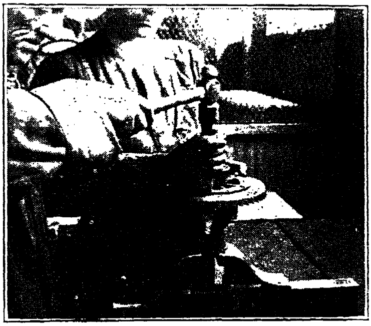


Fig. 31. Riveting a Ring Gear by Hand

When setting up rivets, make certain that the rivet set which is used on the tooth side of the gear is no wider than the space available. If the punch is too wide, the gear teeth may be damaged and the rivet head will not come up flush.

Truing Differential Carrier. Place the differential housing, with the halves bolted together and using the differential hubs as centers, in the lathe, Fig. 27, and revolve it at a good speed, and watch the ring gear. It should not run eccentrically at all and should not weave more than .005. If there is a pronounced running out of true, the ring gear must be taken off the housing and the face of the differential housing, against which the ring gear seats, should be machined true. When this has been corrected, the ring gear may again be bolted on housing and tried as before, and if found correct, the riveting may be commenced. Do not remove the bolts until all the other holes have been filled with rivets and the ends riveted over very tightly.

Bevel Pinion Gear Installation. When installing a new bevel gear, be sure that the key does not stand up too high in the shaft, as this will prevent the gear from being driven on the shaft to its correct position, and it will also make the gear run out of true. An allowance of .002 inch is permissible in this alignment.

A hum will often develop in an axle that was previously quiet. If the hum sounds plainer while the engine is pulling, the gears are too deep in mesh; and if the hum sounds plainer when the car is rolling but the engine not pulling—"on the coast," as it is termed—the gears are not meshed deep enough. Of course, this is governed more or less by the condition of the gears.

A good way to listen to rear axle hums out on the road is to lay back over the rear seat cushion of the car, with the head against the top of the seat. The rear-axle noise is always more readily heard when seated in the rear compartment of the car. The closed car bodies serve to amplify gear noise. This is due to resonance, the body acting as a sounding board. When the sound arising from the axle is a steady hum, the gears are in good condition and well adjusted. If this sound is interrupted occasionally by a sharper, harsher note, it may be assumed that there is a point in one of the gears or on one of the shafts where things are not as they should be. By trying the car at starting, slowing down, running at various speeds, and coasting, this noise can be tied to something more definite, some fixed method of happening. In advance of actual repair work, including tearing down the whole axle, the gears can be adjusted. This can generally be done from outside the axle casing and without a great deal of work. If the adjustment makes matters worse, it can be reversed, or if it improves the situation, the adjusting can be continued, a little at a time, until the noise gradually disappears.

Points of Adjustment. There are three points of adjustment for the meshing of the ring and bevel drive pinion gear in the rear axle. One adjustment is for the movement of the bevel pinion in a fore-and-aft direction and is located at the front of the rear axle housing and just behind the rear universal joint. Sometimes this adjustment is covered up inside the housing as shown in Fig. 32 and is held in place by a locking device that bolts on the outside of the housing. In other types the adjusting nut is screwed directly into the end of the housing. The other two adjustments are located at the side of the differential unit and allow the movement of the ring gear in a left-hand or a right-hand direction. This adjustment moves the ring gear into deeper mesh with the bevel pinion. The position of this adjustment is shown in Fig. 33. In some axles the differential ring gear and bevel pinion can be removed as one unit and this makes it a very easy matter to make an adjustment after the axle has been overhauled. This unit is often called the differential bridge.

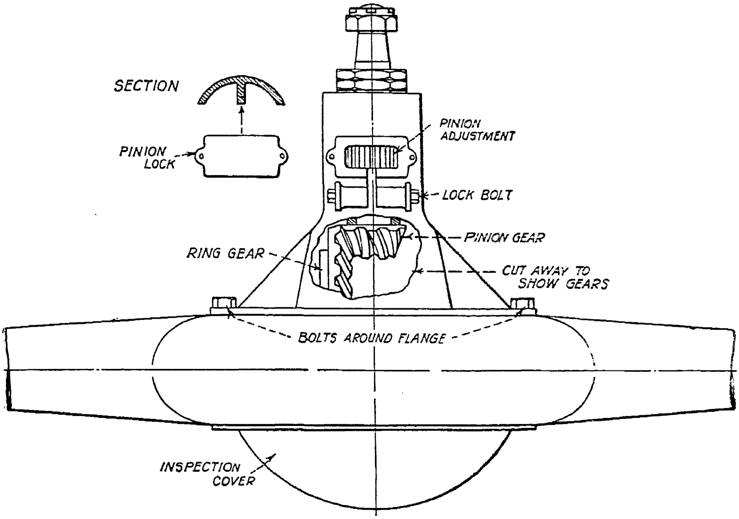


Fig. 32. Fore-and-Aft Adjustment of Bevel Pinion

Rear Axle Gear Adjustment. The method used in adjustment by most repair men is to set the teeth of the gears so that they are flush at either the large end or the small end, with a clearance between the teeth of about .005 or .010. Although this is very satisfactory, it does not insure a perfect adjustment and should be forgotten if a perfect adjustment is wanted. A better method, after the axle has been placed under the car, is to paint the ring gear with white paint after the gears have been placed as near as possible to the position stated above. Be sure that the brakes are equalized, so that an even load may be obtained on the rear wheels. Start the engine and put the high gear in mesh. Now put on the brakes, and this will wipe the paint off the teeth. If the marking shows the same as pictured in Fig. 34-h, it is quite correct; and the axle will be found to be perfectly quiet, providing the gears are not worn. In the illustration the teeth are shown in full contact. This is the ideal condition and will give perfectly quiet operation.

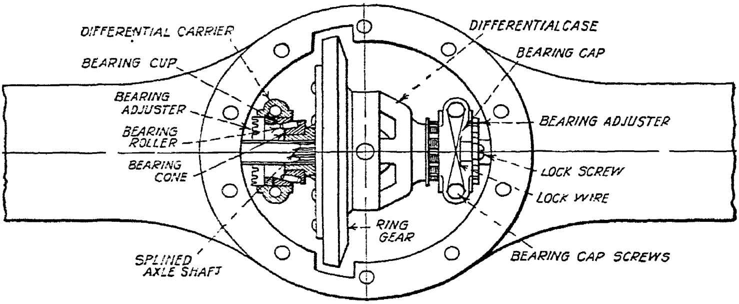


Fig. 33. Ring Gear Adjustment

If the contact is as shown in Fig. 34-d, that is, heavy on the toe of the teeth, the ring gear must be moved away from the pinion. If gears were left to run in this way, the toe would eventually break off.

Should the markings show as in Fig. 34-e, the bevel pinion or gear should be moved in deeper mesh. It will be noticed that the bearing or contact is the length of the tooth, but it does not go down deep enough, and the same thing applies to Fig. 34-f, only in this case the mesh is too deep. Remedy by moving the pinion away or out of mesh.

Fig. 34-g shows the marking for too much backlash. To correct this, move the ring gear towards the bevel pinion, but be sure you have a slight amount of play between the gears before running the car. Gears set up in this way, if run, will break off at the heel of the tooth.

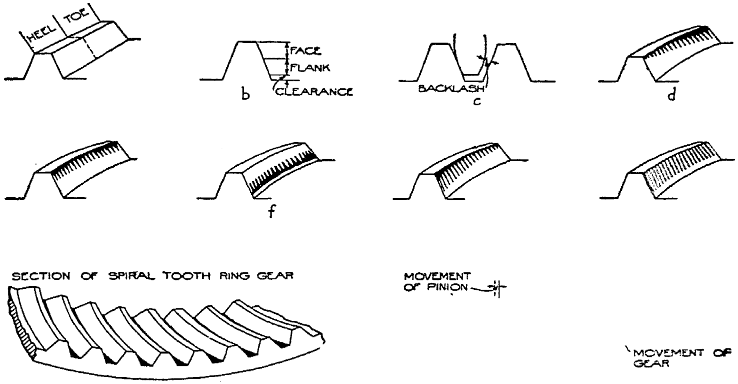


Fig. 34. Tooth Markings for Rear Axle Gear Adjustment

If after continued adjustment, the contact still shows as in Fig. 34-g, the axle must be sprung or the gears are machined incorrectly. The axle should never be left to run with the heavy contact on the heel of the gear.

Fig. 34-j shows two cones, which represent the gears, and illustrates the difference obtained by backlash. In adjusting rear axles it should always be done if possible by moving the ring gear, but of course it is sometimes necessary to move both ring gear and bevel gear a little according to the marking obtained.

A car may be tested a short distance without grease in the housing in case of further adjustment, but do not forget to fill the axle housing before delivery. If, when driving, the axle develops a thump, it is a case of either a broken or chipped tooth on either gear, or the ring gear is sprung out of true. The foregoing method can and should be used in the adjustment of any rear axle of the adjustable type.

Rear Axle Shafts Breaking. There are three reasons for the continual breaking of axle shafts: (1) a grabbing clutch; (2) worn bearings at the wheel end of the axle shafts; and (3) axle housing out of line with axle shaft bent. The second trouble is not so prevalent in axles that have a ball or roller bearing which revolve in their own cups or races, but it is of frequent occurrence where the bearing comes into direct contact with the axle shaft. The bearing wears into the axle shaft and the shaft—being out of true alignment—causes a twisting motion. The shaft becomes gradually crystallized and breaks off. The cure is to keep the bearings well lubricated and at the first signs of wear the axle should be replaced. Wheel bearings of any kind should always be carefully adjusted and well taken care of. Frequent inspection and cleaning is half the battle towards long life and service of the bearing. To make an inspection for bearing play, jack up the rear wheel and push and pull on the wheel. This motion will show if there is any side play on the bearings. Take hold of the top and the bottom of the wheel and use a rocking motion, which will show if there is any up and down play. If there is, the bearing should be renewed. *Should the axle housing be out of alignment or the shaft bent, it will break in service eventually.*

REAR AXLE OVERHAUL—FORD V-8

The basic principles of the car and truck axles have been three-quarter floating with torque tube drive. This design places the entire load and the road shock on the axle housing, relieving the axle shaft of all strain other than the actual transmission of power to the wheels.

The torque tube drive delivers the road thrust directly to the frame cross member, holding the axle always in correct position regardless of the size of the load or speed of the car or

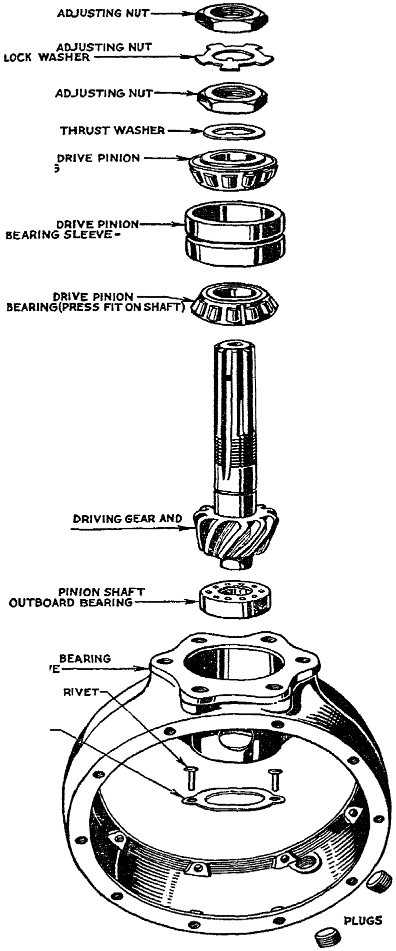

ADJUSTING NUT
ADJUSTING NUT LOCK WASHER
ADJUSTING NUT
THRUST WASHER
DRIVE PINION
DRIVE PINION BEARING SLEEVE
DRIVE PINION BEARING(PRESS FIT ON SHAFT)
DRIVING GEAR AND
PINION SHAFT OUTBOARD BEARING
BEARING
RIVET
PLUGS

Fig. 35. Pinion Shaft, Gear, and Differential Housing

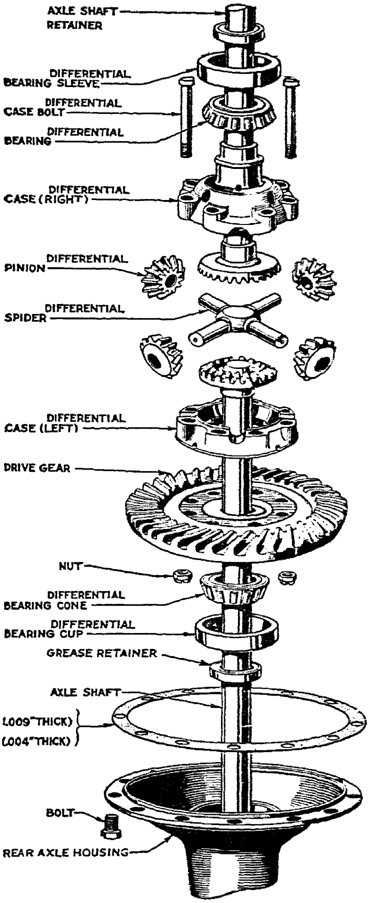


Fig. 36. Differential Carrier, Side Gears, Spider Gears, Ring Gear, Shaft, Bearing, and Rear Axle Housing

when the brakes are applied. With the torque tube drive, the springs support the load and are not used to transmit the road thrust or absorb the axle twist when brakes are applied or motor is accelerated. This torque tube, pivoting at approximately the same point on the frame as the brake cross shaft, permits the brake rod adjustment to remain the same regardless of the size of the load.

Owing to the high degree of accuracy obtained by the use of special Ford developed machinery used in the manufacture of the component parts of the rear axle, the location of the drive pinion and drive gear are permanently correct and require no adjustment other than such adjustment as may in time be required to compensate for wear.

During November, 1933, a change was made in the method of mounting the drive pinion gear as shown in Fig. 35. This method of mounting, generally referred to as "straddle mounted," prevents any possible misalignment between the driving members as a result of the exceptionally high torque developed by the present engines. This type of mounting was adopted on all truck axles during 1929.

It will be necessary to have certain tools for both the assembling and disassembling of the various rear axles. Bearings, bearing cups, and grease retainers must be pressed in place absolutely straight or they will affect the accuracy of the entire assembly. Figs. 35, 36, and 37 illustrate the various parts entering into the axle arranged in the proper relation to each other. A study of these drawings should familiarize mechanics with the construction and arrangement and assist in the disassembling of the axle.

Fig. 38 shows the method of removing the drive pinion as an assembly by means of the driver. Fig. 39 illustrates the method of removing the pinion bearing from the pinion shaft with the puller. Fig. 40 illustrates the method of removing the differential bearing cup with the puller.

Inspection. New roller bearings and bearing cups should be installed if those removed show indications of excessive wear or are pitted. The differential case should be examined for wear at the point where the backs of the differential pinion

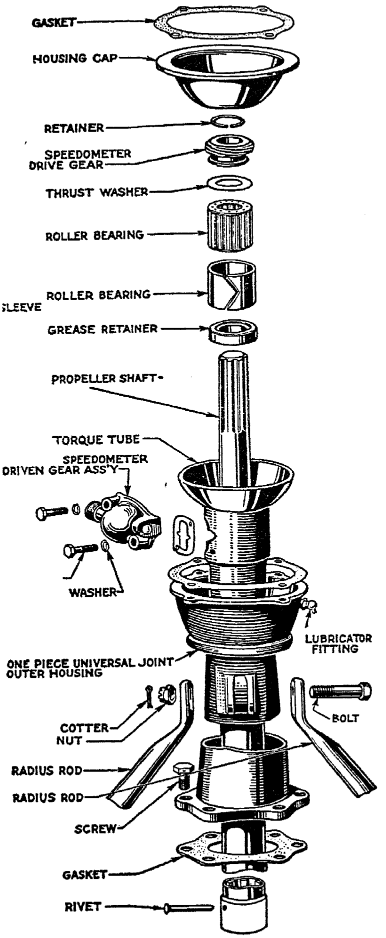


Fig. 37. Torque Tube with Parts in Order of Assembly

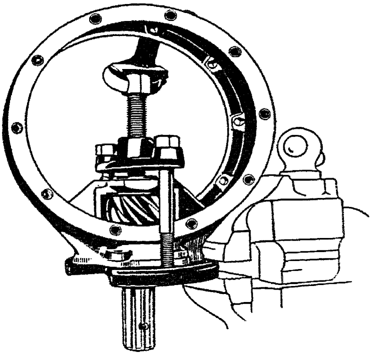


Fig. 38. Removing the Drive Pinion Assembly

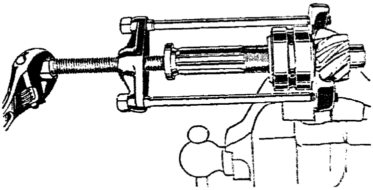


Fig. 39. Removing the Pinion Bearing from Pinion Shaft

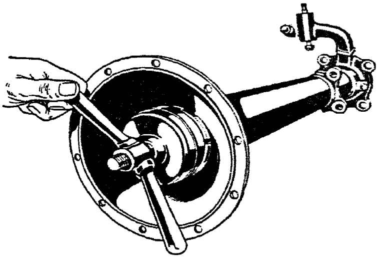


Fig. 40. Pulling the Ford V-8 Differential Bearing Cup

and axle shaft gears contact the two halves. If there is indication of excessive wear at these points, a new differential case should be installed. The axle shafts should be examined for wear on the taper, damaged keyway or threads (it is a good plan to install the axle shaft nuts part way on the shaft to protect the threads while the axle is disassembled) also if the gear teeth are worn excessively or the back of the gear is scored the shaft should be replaced.

If the differential spider, Fig. 36, shows sign of excessive wear at the differential pinion bearing, the spider also should be replaced. Examine the differential pinion gears for wear on the teeth or in the bearing. If the wear at these points is excessive or if the backs of the gears are scored, the gears should be replaced. The drive gear and driving pinion should be examined for excessive wear or damaged teeth.

The bearing surface of the propeller shaft should be inspected and if worn to .005″ undersize the shaft should be replaced as well as the bearing and sleeve. The axle housings should now be checked. If the rear wheel bearings surface is scored, badly pitted or worn more than .010″ undersize for more than three-fourths of its length, the housing should be replaced. Some variation to this rule is permissible depending on the type of service in which the axle is to be used and the type of performance the owner desires. If the shock absorber link balls are badly worn, they should be replaced.

The grease retainers in the axle housings and torque tube, Fig. 37, should always be replaced when the axle is overhauled. Install the retainer in the torque tube with the sharp edge of the leather toward the universal joint. Install the retainers in the axle housings with the sharp edge of leather toward the differential.

Radius rods which have been badly bent should be replaced as the straightening of them usually elongates them. (Mechanics however should exercise good judgment in this respect.) The use of bent or elongated radius rods changes the center line angle of the torque tube and the axle proper, placing a severe continuous strain on all the gears and bearings which may cause excessive wear and unsatisfactory performance of the axle as a whole, and results in misaligned rear wheels.

Assembling. Assemble the driving pinion bearing cones and cup to the driving pinion (see Figs. 41 and 42), adjusting the bearing lock nuts so as to obtain correct fit. The bearing cup should turn on the cones with a heavy drag and no end play.

The correct adjustment for the straddle mounted axle pinion bearings, expressed in inch pounds, is 20- to 25-inch pounds, and for the previous design axle 35- to 47-inch pounds effort is required to turn the pinion when correctly adjusted.

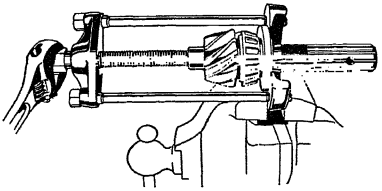


Fig. 41. Installing the Ford V-8 Rear Pinion Bearing

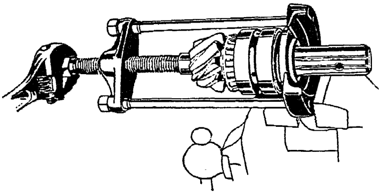


Fig. 42. Installing the Forward Pinion Bearing

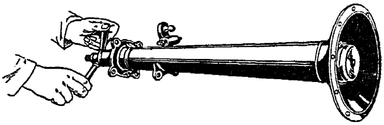


Fig. 44. Installing the Differential Bearing Cups

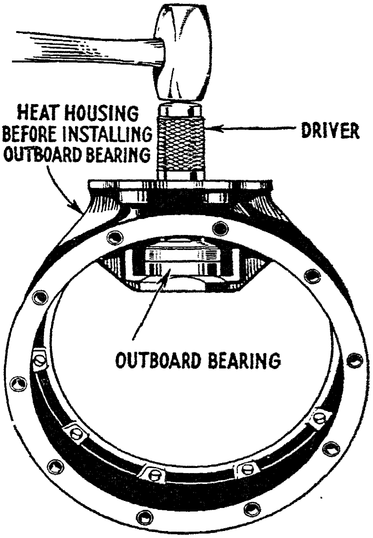


Fig. 43. Installing the Outboard Bearing

Lock the bearing adjustment by means of the driving pinion bearing lock washer.

To install the differential driving pinion bearing cup, it is necessary to heat the differential housing at the "neck," using the V-61 stand and blow torch or by immersing it (for 1 to 2 minutes) either in boiling water or heated oil. Be sure that the shoulder in the differential housing is clean and free from burrs. When the housing is heated, install the outboard bearing using the driver as illustrated in Fig. 43, then install the driving pinion assembly while the housing is still hot, making certain that the bearing cup is against the shoulder of the housing. It is important that the housing be heated when the driving pinion bearing cup is installed. Fig. 36 illustrates the various parts that so far have been assembled. The differential bearing cups are assembled to the two axle housings by means of the puller, as shown in Fig. 44. The rear axle shaft should be placed in the right-hand half of the differential case. Place the spider to which the pinions have been added in the differential case. The pinions should turn freely on the spider (approximately .005″ clearance). The other axle shaft and the other half of the differential case and the drive gear should be installed and the whole bolted together tightly and a locking wire installed. (The joints of the differential case must be free from burrs or anything which would prevent them from joining incorrectly.)

Back lash in the axle shaft gears may now be checked. This may be done by holding one shaft securely in a vise and turning the other as far as possible by hand, first in one direction and then the opposite. The amount of free travel will indicate the total amount of back lash in the assembly. The amount of travel allowable checked at the key way of the axle shaft should not exceed .010″. If the back lash exceeds this, the end play of the shaft should be checked. This should not exceed .015″ on either shaft. Greater end play is an indication that some of the parts are worn excessively and have not been replaced or that the assembly has been incorrect—probably the halves of the differential case have not been seated properly. However, if the end play is not excessive and the back lash is more than designated, it is usually an indication of excessive wear on the teeth of some of the gears.

Install the differential bearing cones to the gear and the differential case (right) using the driver to install them. Assemble the left-hand axle housing to the differential housing using a gasket which is .008″ to .010″ thick. The differential assembly should then be installed at the left-hand housing. The left-axle housing should then be assembled to the differential housing with a gasket which is .008″ to .010″ thick and all housing bolts securely tightened.

The differential bearing clearance may now be checked. Two men are necessary to do this. Each should turn one of the axle shafts; both shafts must be turned in the same direction and approximately the same speed. With correct clearance, a heavy drag should be felt when the differential is turned on its roller bearing. The turning of only one axle shaft does not revolve the differential on its bearings. If the clearance is too great, the gasket between the right-hand housing and the differential housing should be replaced with the gasket which is .004″-.005″ thick and the clearance again checked.

Back lash between the drive pinion and ring gear should now be checked at the splines of the drive pinion shaft with an indicator to show the movement obtainable. It should never be greater than .008″ or less than .003″. The increasing of the gasket thickness between the left-hand housing and differential housing increases the back lash, whereas decreasing of the gasket thickness between the left-hand housing and differential housing decreases the back lash. However, in order that the correct differential bearing adjustment already obtained, be preserved, it is necessary that whatever gasket thickness is added to the left-hand housing should be removed from the right-hand housing, or whatever gasket thickness is taken from the left-hand housing should be added to the right-hand housing. The propeller shaft should now be riveted to the drive pinion and the torque tube installed. Fig. 37 illustrates the various parts of this assembly positioned in the order of their assembly.

Summary. Too much back lash between gears causes tooth breakage, too little causes objectionable growling noises. The same generally applies to the clearance between the bearings and their cups. Oil leakage at the rear wheels usually can be attributed to too high an oil level in the rear axle. The level of the lubricant should be checked and the surplus, if any, removed at each 1000 mile lubrication. Axle shaft breakage at the taper end is usually caused by loose fit of the hub on the shaft, (this looseness should be occasionally taken up, particularly after a new hub or axle shaft has been installed), badly worn or unlubricated rear hub roller bearing, and excessive overloading.

Broken teeth in the drive gear and pinion are caused by excessive back lash probably due to distorted differential housing or badly worn differential housing bearing. Broken teeth in the gears of the differential are usually caused by excessive back lash, loose differential case bolts, and excessive wear.

Lack of lubrication is the most common cause of axle failure and every effort should be put forth to impress upon owners the importance of lubricating rear wheel bearings, the draining, flushing, and refilling of the differential housing twice yearly or every 5000 miles, as well as replenishing the lubricant when needed as indicated by the inspection given at each 1000 mile lubrication.

DUAL RATIO AUBURN AXLE

The dual ratio axle is designed to give the motorist a low speed ratio of 4½ to 1 and a high speed ratio of 3 to 1 in the case of the particular axle used for the Auburn "12." In the case of the Auburn "8," the high speed ratio is 3½ to 1 and the low speed ratio is 5.1 to 1.

By shifting the axle into the low speed ratio, rapid pickup and power for hills and other hard going is available. When cruising on the open highway where the going is mostly level, the motorist may shift the rear axle into the high speed ratio, thereby cutting down the engine revolutions in ratio to the distance covered.

An engine operating under load at a lower speed gives longer life than one operating at high speed with relatively light load and racked with vibration.

The shift from low to high or vice versa is readily made. Pre-selection of gear ratios is possible by means of the positioning of a small lever on the dash or instrument panel. After positioning the lever, the clutch pedal is depressed. This opens a valve permitting suction from the engine to operate through a cylinder on the rear axle, shown in Fig. 45, thus making the shift entirely automatic insofar as the actual operation of the parts is concerned.

Aside from the actual details of construction and shift, which are shown in sectional view in Fig. 46, automotive men will be interested in knowing that the high speed or second ratio is secured by means of a planetary gear set incorporated in the rear axle differential case assembly. A dog type clutch operating on the axle shaft is used to engage the planetary transmission. The shifting of the dog clutch is controlled by the clutch pedal.

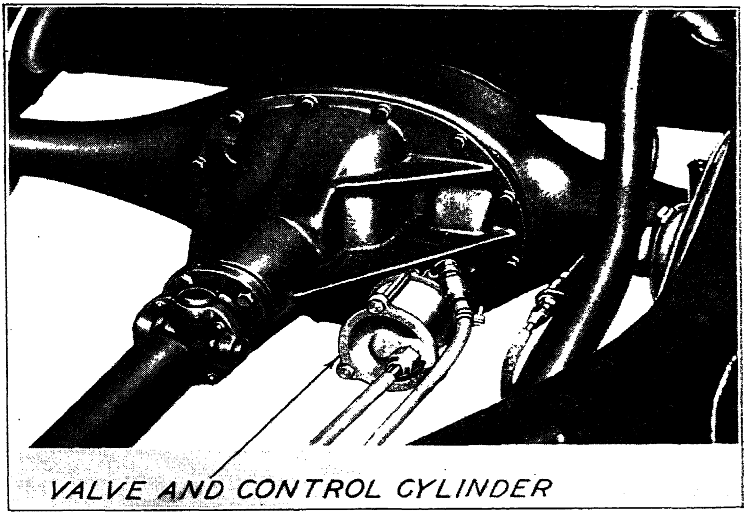


Fig. 45. Auburn Two-Speed Rear Axle with Vacuum Gear Shifter

The minimum gear ratio of 4½ to 1 is a constant ratio between the ring gear and pinion and does not involve the planetary transmission, which merely revolves as an integral section of the ring gear, planetary gear case, and differential case assembly. The maximum gear ratio or high-high is developed through a connection with the planetary "step-up" gearing, which develops between the engine and the rear axle a ratio of 3 to 1. Thus when the high-high gear is in operation, the engine turns one-third less revolutions per wheel revolution than when the power is transmitted direct from the ring gear to the axle shafts. Naturally, the advantages which are inherent in high gear transmission position are also available for use in low, intermediate, and reverse positions. In other words, two reverse speeds, two low speeds, two second or intermediate, and two high speeds are available. The construction of the over-drive planetary gear set is evident in Fig. 46.

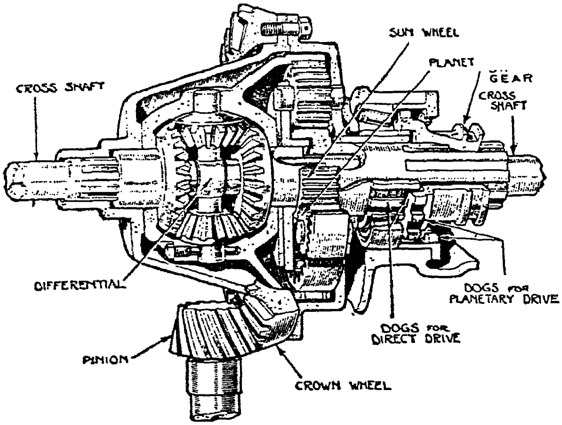


Fig. 46. Auburn Two-Speed Rear Axle Gear Set

LUBRICATION

Lubrication is one of the most important services which may be performed on the rear axle. Most rear axles are designed with a filler plug opening, which is also the gauge of the proper lubrication height. Do not fill above the filler plug hole. When the inspection plate is off the rear axle, where such is used, do not reverse it when replacing, as this would allow the grease to come over the center of the ring gear and differential housing if the axle housing was filled to the filler plug in the reversed position.

Some years ago, cup grease was considered a good rear-axle lubricant. Occasionally misinformed service men still use this type of lubricant. The better type of lubricant is more on the order of the fluid transmission or differential grease. Even this is likely to solidify and channel in cold weather. By channeling is meant the cutting of a track through the lubricant by the ring gear, which throws out the lubricant cut loose, with the result that presently the gears are running between two walls of solidified grease but without any lubrication. A small amount of kerosene may be added to lubricant that tends to jell or solidify in cold weather in order to keep it fluid.

Draining and Flushing the Differential. Small particles of steel and cast-iron chips from the machining operation may be left in the rear-axle housing or may appear in the lubricant after some miles of service. There are several ways to detect the presence of metallic parts in the lubricant. If a bit of the grease is rubbed between the fingers, any grit will become apparent both to the feel and the eye. Another way of testing is to use a magnet which may be dipped into the differential grease and then washed off in a pail of gasoline. Any steel particles will cling to the magnet. Drain, flush, and refill if metallic particles are found.

Cracking Noise in Rear Wheel as Clutch Takes Hold. This trouble may be caused by the wheel being loose on the axle and the key may not be a good fit in the keyway in the axle or in the keyway in the wheel hub. It should be corrected as soon as possible or the key may be sheared off or the keyways in both axle and hub will be badly worn, necessitating a new axle and wheel hub. If the rim is not tightly bolted to the rim, it will move as the wheel starts to turn and will also cause a cracking noise.

Rubbing Noise in the Rear Wheel. This noise is usually more pronounced as the car rounds a corner or a curve and is caused by the wheel being loose on the axle or by end play in the axle shaft. The noise is made by the brake drum rubbing against the shield at the back of the wheel. To cure this, the wheel should be tightened on the axle or the rear wheel bearings examined and adjusted according to the trouble found.

UNIVERSAL JOINTS

Final drive is through universal joints and a propeller shaft. When it is remembered that the rear axle is swung on springs and the car is in motion over the roadway, the distance between the car frame and the center of the axle housing is a constantly changing one. The need of some form of more or less flexible drive is evident.

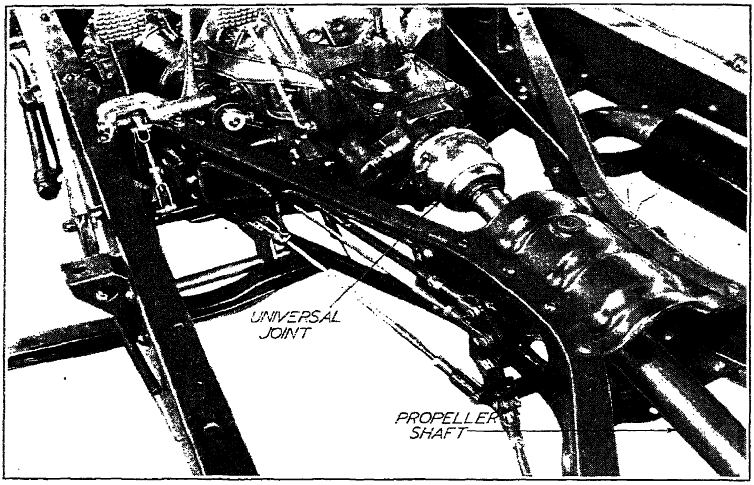


Fig. 47. Propeller Shaft and Universal Joint of the Terraplane Car

Fig. 47 shows a section of the Terraplane frame with the propeller shaft and universal joint. It will be noted that there is a slight angle between the propeller shaft and what would be the center line of the transmission shaft, which shaft supports the flange on which the universal joint is bolted.

The simple joint shown at *A* and *D*, Fig. 48, illustrates the principle on which universal joints are designed to operate. At *A* it will be noted that the forward shaft is being turned and that this in turn rotates a rear shaft, although the rear shaft is at an angle with the forward shaft. This simple shaft makes use of two yokes, having between them a cross to which they in turn are bolted or fastened. The simple joint at *D* makes use of a central block to which the two yokes are attached. The universal, indicated in partially disassembled view at *B*, Fig. 48, is of the same general type as the one shown in Fig. 47.

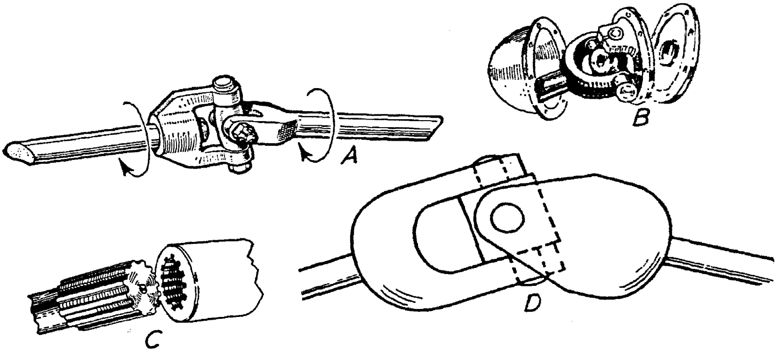


Fig. 48. Simple Universal Joint at *A* and *D*, Production Universal Joint at *B* with a Slip Joint Illustrated at *C*

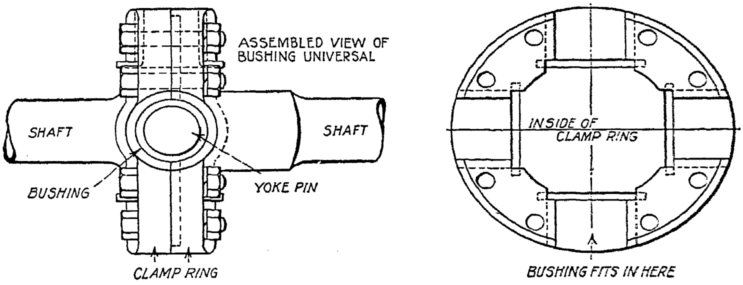


Fig. 49. Bushing-Type Universal Joint

Metal Universal Joints. In this type of universal joints, the different parts are all metal and are made in several forms. (1) The bushing type—the bushings are held between two clamp rings, the bushings being free to move on the universal joint yoke pins, Fig. 49. (2) The center-block type—the center block is held in place by long pins which pass through the yokes, Fig. 50. (3) The circular-yoke type—the rollers, which revolve on the yoke pins, are held in place by lock rings over all of which is placed an oil-tight cover, Fig. 51. The details of the universal joints shown in Fig. 49 are shown in Fig. 52. In the first type, great care should be taken in the fitting of the bushings for they must fit tight in the clamp rings but, at the same time, must move freely on the pins. This type is not as easily lubricated as those that are enclosed in an oil-tight housing. In the second type, the thrust of the block comes on the inside of the yoke and causes wear which often means that all the parts must be renewed at the time of repairing. In the last type, the thrust is taken by the rollers and usually it is only necessary to renew steel rollers at time of overhauling.

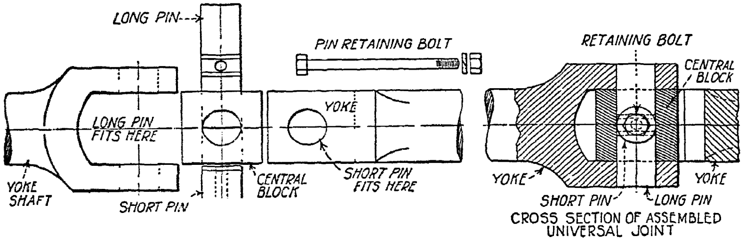


Fig. 50. Center-Block Universal Joint

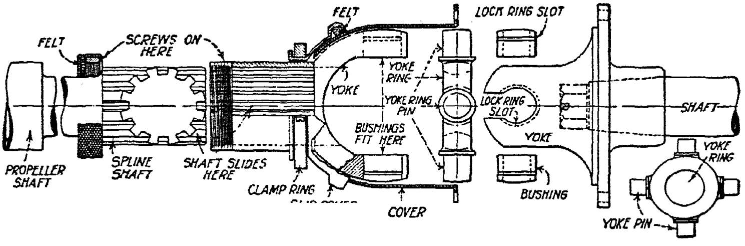


Fig. 51. Spicer or Circular-Yoke Type of Universal Joint

Slip Joints. In many situations, a real universal joint is not needed, since the parts are not actually free to move in all directions; but what is needed is slight freedom up and down or sidewise combined with possible fore-and-aft movement. In such cases a slip is used, the name giving the idea of a joint which allows one shaft to slip, or slide, inside the other. The general construction of slip joints varies.

Splined Joints. It is necessary to supply the universal slip with a splined joint in order to compensate for the varying distance between the transmission shaft at the forward end and the pinion shaft at the rear end. This is especially true when an exposed type of propeller shaft, such as that indicated in Fig. 47, is used. When the rear axle is moving up and down with reference to the car frame, it moves in an arc, this arc being determined by the length of the forward half of the rear spring. We refer here to the Hotchkiss type of drive, ordinarily used in connection with the exposed type of propeller shaft. Since the propeller shaft is not moving on the same arc as that described by the forward halves of the rear spring, it is evident that there will be some variation in the distance between the transmission shaft and the pinion gear shaft which is compensated for by a slip or sliding joint shown at *C*, Fig. 48.

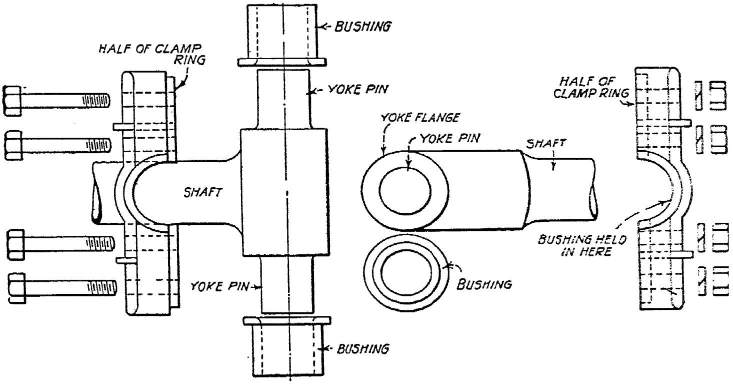


Fig. 52. Details of Bushing-Type Universal Joint

When the torque tube drive is used, the propeller shaft being enclosed, the amount of slip is very little inasmuch as the radius described by the rear axle in motion is the same as that for the propeller shaft. The forward ball on the torque tube is always arranged approximately on a center line with the yoke bushings within the ball joint, which is ordinarily used to connect the forward end of the torque tube with the rear of the transmission housing. A torque tube may be used with spring drive as in the Chevrolet, in which case a slip joint must be used.

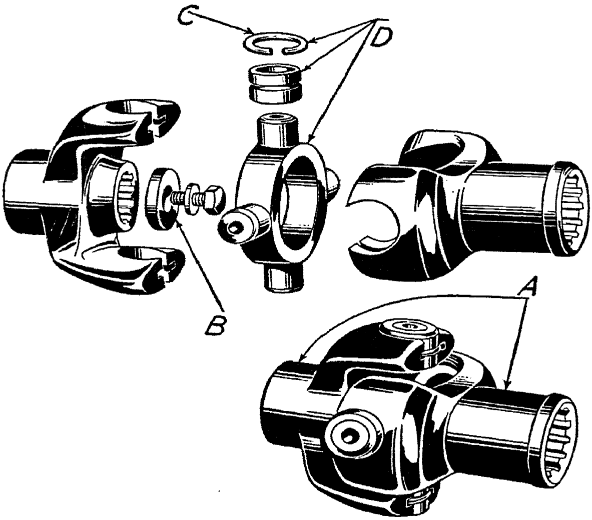


Fig. 53. Ford V-8 Universal Joint, Disassembled and Assembled Views

Ford V-8 Universal Joint. The Ford V-8 universal joint is illustrated in Fig. 53, in the upper views in disassembled form and in the lower view, *A*, in assembled form. This universal joint is quite similar to that used in the Model "A" and "B" Fords. Fig. 54 illustrates the forward end of the propeller shaft, *E*, housed in the torque tube, and the rear of the transmission housing to which it is fitted. It will be noted that the bolts *X* are used to secure the parts together at the joint marked *A*. The forward end of the ball housing which is carried on the torque tube is indicated at *B* and this is fitted to the inner housing marked *A* and under the outer flange marked *D*. As the load of the automobile puts the rear springs into motion, there is a continual oscillation of the part *B* within the two parts housing it. It will be noted that the parting line of the ball housing is almost in line with the center of the yoke so that there will be very little fore-and-aft motion of the propeller

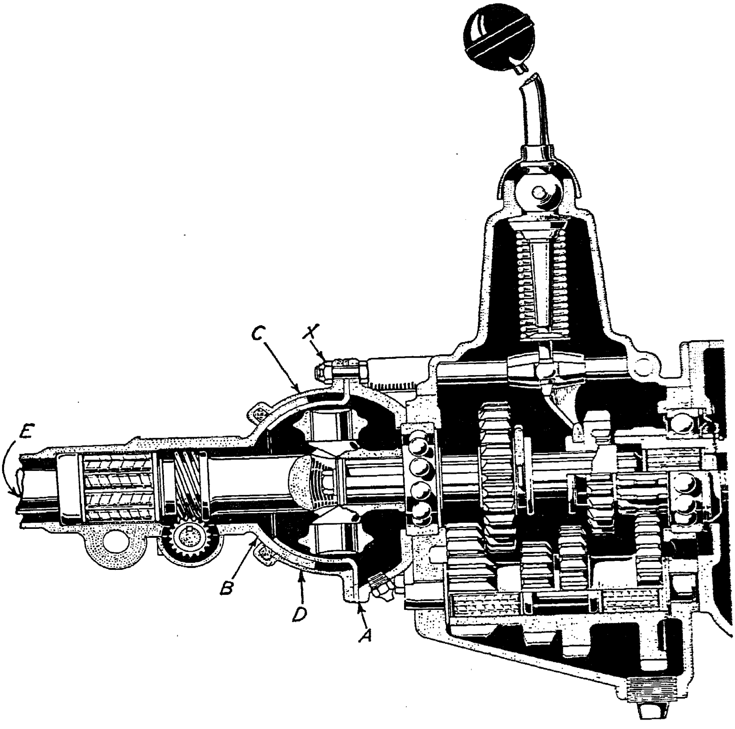


Fig. 54. Model "A"—Ford Transmission and Torque Tube Assembly with Universal Joint Enclosed

shaft in relation to the end of the transmission shaft. This type of drive utilizes but one universal joint, this being at the forward end of the propeller shaft.

Spicer Universal Joint. This type of joint is ordinarily used for the exposed propeller shaft. The upper cut *A*, Fig. 55, shows a rear universal joint in part section and cut *B* illustrates a forward universal joint in part section. Note that the forward joint only is provided with a split joint. A pictorial view of these two joints on a propeller shaft is shown in Fig. 56. The flange for mounting the rear joint to the pinion gear shaft is shown in Fig. 57.

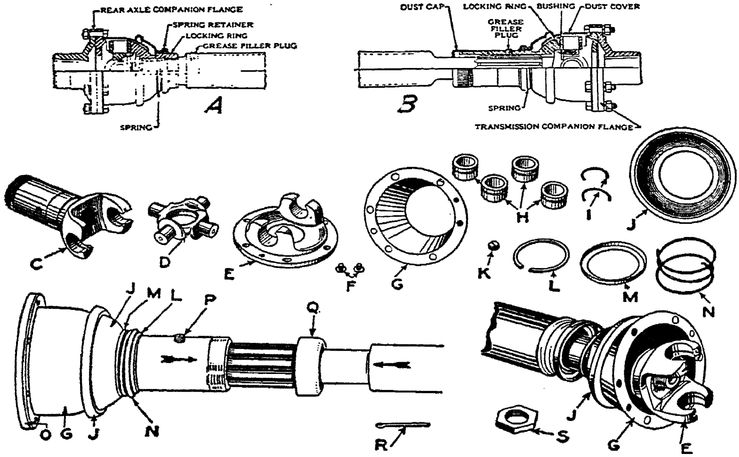


Fig. 55. Spicer Type of Universal Joint, Showing Assembled and Disassembled Views

Ordinarily it is possible to quickly remove a propeller shaft with a universal joint of the Spicer type from the car. This is done by removing the six 5/16″ screws and nuts used to hold each joint to its flange. Be very careful when removing the joint to prevent the assembly from dropping to the floor.

When disassembling a forward Spicer universal joint, first turn back the dust cap, marked *Q*, Fig. 55, next bring out the lock washer *L*, this will allow the spring *N* and the ring *M* to come away. After these have been removed slip away the dust cover *J*. This will expose the inner yoke and cross together with the bushing. Next remove the lock wires *I* which hold the bushings *H* in position on the cross shaft in the yoke *C* and flange yoke *E*. The bushings slip out to the ends of the cross after the lock wires have been worked out. A screw driver under the lock wires is usually the best method of removing them.

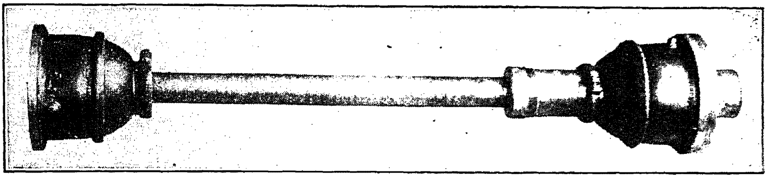


Fig. 56. Propeller Shaft with Two Universal Joints

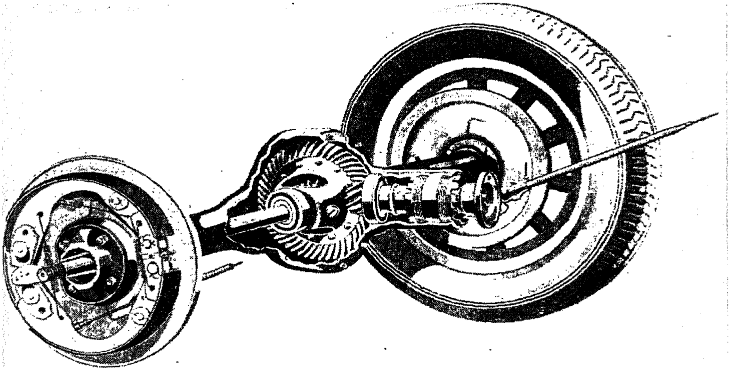


Fig. 57. Flange for Mounting Rear Joint to the Pinion Gear Shaft

When disassembling the rear universal joint, it is necessary to remove the nut *S*, Fig. 55. After this has been removed the spring, lock ring, and dust cover may be slipped off the stub shaft. At this point it is possible to inspect the bushings and yokes to see if they are in good condition. If they are not, it will be necessary to further disassemble the joint. When checking up on the Spicer universal joint, check on the splines on the slip joint both for the inner splines on the yoke *C* and the outer splines on the propeller shaft front end to see whether undue wear has occurred. Note that the universals are ordinarily marked with arrows indicating the splines which are supposed to fit together. Sometimes these shafts are balanced in this position and to place them in another position puts the shaft out of balance with very unsatisfactory operating characteristics, because of the vibration set up which disturbs the occupants of the car.

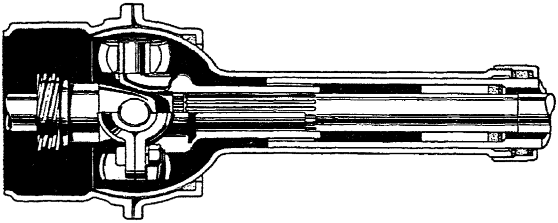


Fig. 58. Pontiac-Chevrolet Type of Universal Joint

Ordinarily most wear occurs on the cross *D* or on the bushing into which it is fitted. It is also a good idea to check on the yoke *C* and yoke flange *E* to see whether wear has occurred where the bushings fit into these two units, which may be the case when the joint has been operated over a long period of time without proper lubrication.

The Spicer Manufacturing Company supplies a universal joint lubricant which is highly recommended for this type of service. This is a fiber grease so designed as to properly lubricate the universal joint, while at the same time it is held within the joint in a satisfactory manner. When lubricating a Spicer universal joint, do not fill the joint full of the fiber grease, one or two ounces at the most being ample. Ordinarily one application of grease is sufficient for 2,000 to 5,000 miles of service.

Pontiac-Chevrolet Universal Joint. As noted in Fig. 58 this universal joint, which is used at the rear of the transmission within the ball joint provided by the ball housing, which is fitted over the forward end of the torque tube with a slip joint, is enclosed in an oil-tight housing. The forward half of the housing encloses the speedometer drive gear. In this type of construction the tubular propeller shaft is a continuation of the rear axle pinion drive shaft and is splined to it. The front end of the shaft is supported by two self-oiling bronze bushings. The universal joint is fitted with four hardened and ground steel bushings which are held in place by a retaining collar. The rear universal joint yoke is supported in a bronze bushing pressed into the front end of the torque tube.

When disassembling this universal joint, first disassemble the universal ball by removing the cap screws holding the joint ball retainer collar to the ball, then slide the universal joint ball back on the propeller shaft housing. Next separate the universal joint rings by removing the four nuts. The rear yoke and propeller shaft and housing may then be dropped down, making all parts of the universal joint accessible. The rear yoke can be pulled off the splined end of the propeller shaft. Unscrew the cap screw holding the forward yoke to the transmission shaft and remove it. After the parts of the universal joint have been thoroughly checked, the reassembling may be started. The operations here are just the reverse of the disassembling operation with the exception that care must be taken to see that the trunnion bearings are assembled to the yokes with the beveled side of the bearing toward the inside of the yoke. A special tool is used for this. This will assist in holding the front half of the yoke and the front ring while the nuts are being started on the cap screws.

After the universal joint has been installed back on the car, with the joint ball and collar in their proper places, remove the pipe plug on the top of the universal joint ball retainer on the rear end of the transmission and fill this part with transmission lubricant. This universal joint will require no further lubrication as additional lubrication needed is received periodically from the transmission.

Mechanics Universal Joint. The joint illustrated in Fig. 59 is used by a number of car manufacturers. It will be noted that the companion flange, that is the flange which bolts to the flange on the transmission shaft or forward end of the pinion gear shaft at the rear axle, is made somewhat longer having retained within it a pin to which the bushings are fitted at either end. These bushings are retained within rings which are designed to be held together by means of bolts running through both rings and clamping the parts snugly together. It will also be noted that this joint is marked with arrows indicating the position of assembling the parts. The disassembling of this joint for repairs is quite similar to that of any other universal joint. An inspection of the parts when the joint has been disassembled will disclose whether or not undue wear has occurred. Wear within universal joints of course is offset by proper lubrication. In the case of the mechanic type universal joint, lubrication should be by means of grades C or 600-W. Under no circumstances use grease for lubricating these joints. When lubricating, the first operation is to turn the joint until the plug marked *A* is on the top of the joint. The plugs *A* and *B* are found on the outer side of the universal joint body. In order to lubricate remove the upper plug *A* as well as the lower plug *B* and insert an oil gun into the lower opening, forcing in oil or lubricant until the lubricant starts to flow from the upper vent or plug hole *A*. If a suitable oil gun is not

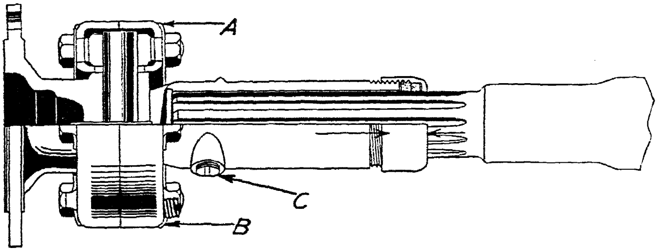


Fig. 59. Mechanics Type of Universal Joint

at hand, a simple expedient is to make use of a standard fitting, fitted in lightly and make use of a grease gun. After the lubricant has been filled in, first replace the plug at *A* and then the one at *B*. Under no circumstances allow the fitting to remain as oil would be lost at high car speed. The splined yoke is lubricated at *C* with any good grade of cup grease. Mechanics universal joints should be lubricated semi-annually for average service. When service is unusually hard, they should be lubricated more frequently.

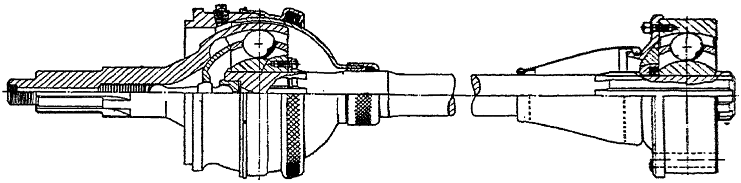


Fig. 60. Rzeppa Front Drive Shaft and Joint Assembly with Thirty-Seven Degrees Outboard Bell Joint and Fifteen Degrees Inboard Disc Joint with Sliding Splined Shaft

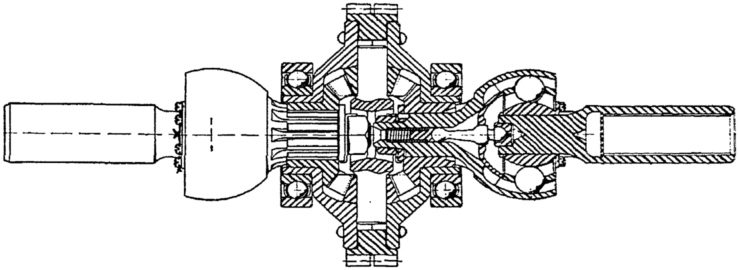


Fig. 61. Rzeppa Differential Mounted Bell Joint for Multiple-Wheel Drives with Two High-Angle Bell Joints

Constant Velocity Universal Joint. The average universal joint is subject to variations in the speed of the driven shaft, as the angle of drive increases this variation increases. In order to secure a joint which is free of pulsations at any working angle, the joints illustrated in Figs. 60 and 61 were developed. The rate of change in speed above or below constant normal may be expressed in percentage approximately by squaring the number of degrees of operating angle and dividing by thirty. This holds with reference to the ordinary four point double yoke joint. This imperfect motion is the cause of torsional vibration of high speed propeller shafts, particularly at critical speeds where the vibration coincides with the natural frequency of the system, as determined by its inertia and elasticity. Ordinary universal joints, while quite satisfactory for use where the angle of drive is slight, are not satisfactory for application such as the front wheel drive with a full steering range when the ordinary joint tends to set up a severe whipping action of the steering wheel because of the variable speed at which the road wheel is being driven. These disadvantages are offset by the design illustrated in Figs. 60 and 61 which shows the Rzeppa joint. This type of joint has been used for racing cars, front wheel drive and in other cases of unusually hard joint service. It is adaptable to any universal joint service in light passenger cars or heavy duty busses and trucks.

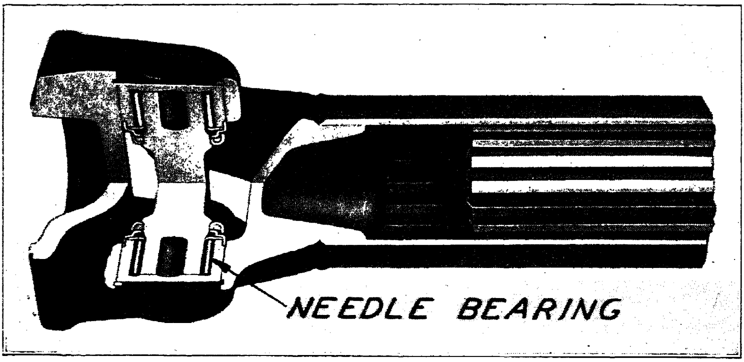


Fig. 62. Needle Bearing Universal Joints Require No Lubrication During the Life of the Car

Needle Bearing Universal Joint. The needle bearing universal joint is illustrated in Fig. 62. This makes use of what might be called a roller bearing for the craft yoke in the universal construction. While these bearings do not rotate round and round, they have an oscillating motion which rocks the yoke forth and back on the needle bearing with the result that while practically all friction is eliminated, long life is also accomplished.

OLDSMOBILE TRIPLE-JOINTED PROPELLER SHAFT

As shown in Fig. 63, the 1937 Oldsmobile cars make use of a two-piece propeller shaft with three universal joints, the center one being carried on a bracket mounted in the X-member at the rear. The triple-jointed propeller shaft permits lowering of the floor so as to provide more ample room in the rear compartment with a minimum amount of tunneling required for vertical motion of the propeller shaft. The center point is hung in a ball bearing mounted in rubber, this medium being used for insulation purposes. The roller bearing universal joint is used at the transmission end of the front propeller shaft and at both ends of the rear propeller shaft. The construction features of the shaft are illustrated in detail in Fig. 64.

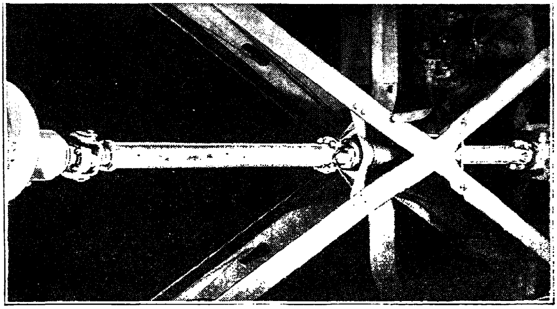


Fig. 63. 1937 Oldsmobile Triple-Jointed Propeller Shaft
Courtesy of Olds Motor Works

If it should be necessary to disassemble the universal joints, all parts should be thoroughly washed and cleaned, after which the spider is filled with S.A.E. 160 oil before reassembling the joint. Replace the cork packing in each roller bearing assembly before reassembling.

Servicing the Oldsmobile Universal Joint. The following directions are recommended for the procedure in servicing the Oldsmobile propeller shaft assembly. In order to disassemble the universal joint, first remove the propeller shaft assembly. Next, remove the roller bearing assemblies with the integral lugs. To remove the slip yoke, bend up the locking ears on the slip yoke collar. The collar is not threaded on the slip yoke. To remove the two roller bearing assemblies that are assembled directly into the yoke, remove the locking plates and clamp plates. Push one roller bearing assembly toward the spider, thus forcing out the opposite bearing assembly. Next, reverse, pushing on the spider to remove the other roller bearing assembly.

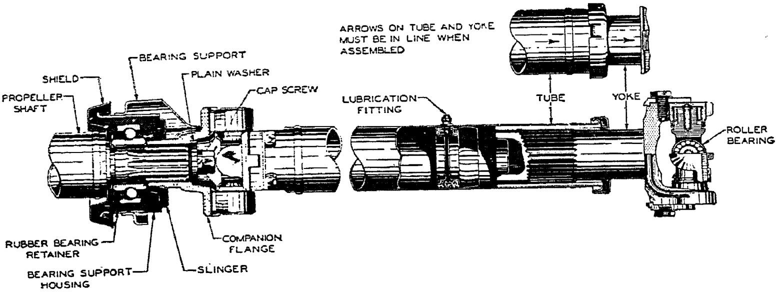


Fig. 64. 1937 Oldsmobile Propeller Shaft Assembly
Courtesy of Olds Motor Works

It may be necessary to remove one dust shield from the spider to remove the spider from the slip yoke.

When reassembling the joint, use new lock plates and be sure the ears on these plates are turned up against the head of the bearing assembly cap screws. When inserting the splines of the propeller shaft into the universal joint, be sure that the arrows on the propeller shaft and joint are in line. See Fig. 64.

To remove the propeller shaft intermediate bearing, detach the front end of both front and rear propeller shafts at companion flanges. Next, loosen the intermediate bearing support from the frame cross-members and remove the front propeller shaft assembly. Support the shaft assembly in a vise at the companion flange and remove the cap screw from the rear end of the shaft. Next, using an arbor press, remove the companion flange from the rear end of the shaft. Remove the pressed steel slinger from in front of the companion flange. Then pull the intermediate bearing support housing and bearing assembly off the rear end of the propeller shaft and slide the rubber retainer from the bearing support.

To replace the propeller shaft intermediate bearing, clean all metal parts in kerosene or gasoline. Clean the rubber retainer by wiping with a clean rag before reassembling the intermediate bearing. Then install the rubber retainer over the ball bearing and tap bearing onto the propeller shaft with the lip on the rubber for a slinger toward the rear of the car. Coat the outside of the rubber with liquid soap or glycerine and slide the bearing support housing over the rubber retainer, with the flat side of the housing toward the front of the car. Next, install a pressed steel slinger back of the ball bearing with the flange over the outside of the lip on the rubber. Press the companion flange in place, crowding the pressed steel slinger tight against the ball bearing inner race. Then install a plain washer, cap screw, and lockwasher in the rear end of the propeller shaft, which, in turn, is installed in the car frame.

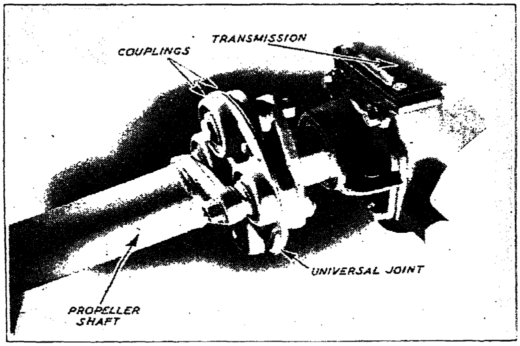


Fig. 65. Studebaker (1937) Dictator Universal Joint
Courtesy of The Studebaker Corporation

STUDEBAKER RUBBER MOUNTED UNIVERSAL

The assembled view of the forward end of the Studebaker propeller shaft and the rear of the transmission case with the rubber mounted universal connecting these two is shown in Fig. 65. In Fig. 66 the transmission shaft splined flange is shown on the right and the propeller shaft flange on the left. In the central part of Fig. 66 is shown the disassembled universal unit. It will be noted that the rubber insulating discs are carried in the pressed steel flanges to which they are assembled by means of the bolts, nuts, and washers shown. The rubber insulation is depended on to absorb any vibrations originating either from the driving of the rear wheels in contact with roadway or from the engine or transmission, and serve to prevent these vibrations from being telegraphed into the car body.

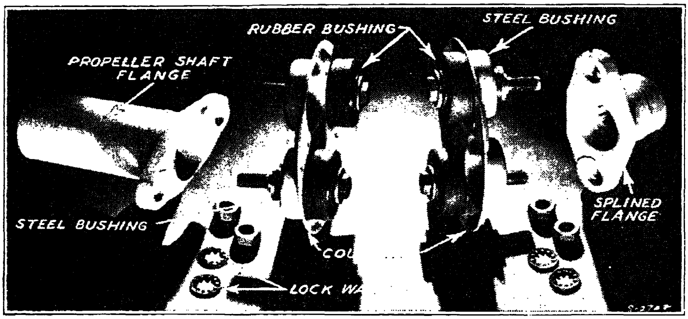


Fig. Studebaker (1937) Dictator Universal Joint Disassembled
Courtesy of The Studebaker Corporation

HYPOID REAR AXLE

The 1935 Chrysler rear axles utilize the Hypoid gear illustrated in Fig. 67. It will be noted, as in all cases of Hypoid gearing, the pinion gear engages the ring gear at a position below a center line. This serves to give a constant gear contact for more teeth, and at the same time results in quieter action and wear of this type of rear axle.

The Hypoid gear is described as being about half-way between a worm gear and a spiral bevel gear set. The study of the illustration will also show that with this construction it is possible to drop down the pinion-gear housing to a point approximately even with the lower part of the ring-gear housing, so that while the propeller shaft is dropped down and affords better room for passengers, the road clearance is not lessened. This type of gearing has an especial advantage where the rear seat of the automobile is moved ahead of the rear axle, affording as it does, an opportunity to use deeper upholstery or bring the floor level to a lower point.

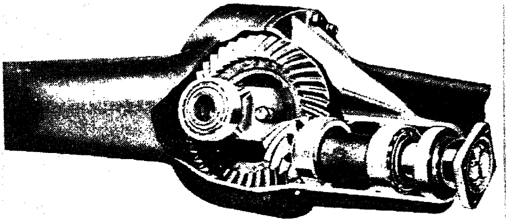


Fig. 67. Chrysler (1935) Hypoid Gearing

Lubricating Hypoid Rear Axles. The widespread adoption of the Hypoid rear axle has been due to an attempt on the part of the car manufacturers to clear up the floor in the rear compartment of the automobile body by removing all need of having a propeller shaft tunnel formed in the center section of the floor. A large number of 1937 quantity-production automobiles make use of this type of rear axle gear.

The action of the conventional spiral bevel rear axle gears is almost wholly one of rolling the teeth over each other. Contrasting to this action is that of the worm drive. The worm gear is almost wholly a sliding action, as the teeth of the worm slide across the face of the gear teeth as they cause it to rotate. The Hypoid drive is said to be a compromise between the bevel gear and worm drive and, as such, comprises both rolling and sliding action between the teeth of the pinion and ring gears.

Owing to this action, entire new problems in rear axle lubrication are faced by lubricating engineers and service men.

Briefly, the points to remember in the lubrication of Hypoid gears are as follows: Only extreme pressure lubricants may be used. Since there are different types of extreme pressure lubricants, they may not be mixed; that is, two brands should not be combined. Where it is necessary to add lubricant and the brand of lubricant in the housing is not known, the best plan is to draw off all lubricant remaining and completely refill. The lubricant must have sufficient toughness to maintain an oil film on the contacting surfaces of the gear teeth and must not contain any corrosive substances nor must it have a tendency to foam or to become stringy.

Steam or water flushers must not be used in flushing out the differential, since with certain brands of Hypoid lubricant chemical reaction will result as the water mixes with certain of the lubricant ingredients, with the result that corrosive substances are formed which will damage the gears.

The lubricant should be inspected each 1000 miles of service and additional lubricant of the same brand added as required. There are two safe methods to follow in lubricating Hypoid gears. One of these is the use of lubricants specified and authorized by the car dealer and manufacturer. The other one is the use of such lubricants as are specified and authorized for use in the axles of certain automobiles by the manufacturers of the Hypoid lubricants. Under no circumstances, mix different brands, as the chemical formulas for the production of these extreme pressure lubricants vary widely and chemical reactions, set up when different brands are mixed, may result in damage to the parts when put in use.

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